Voting System Examination
Hart Verity

Prepared for the
Secretary of State of Texas

James Sneeringer, PhD
Designee of the Attorney General

This report conveys the findings of the Attorney General's technical designee from an examination of the equipment listed, pursuant to Title 9, Chapter 122 of the Texas Election Code, section 122.036(b).

Examination Date:	January 4-8, 2021
Report Date:	February 6, 2021

	Component	**Version**	**EAC Cert. Num.**
1.	Verity Data	2.5.0	HRT-Verity-2.5
2.	Verity Build	2.5.0	HRT-Verity-2.5
3.	Verity Count	2.5.0	HRT-Verity-2.5
4.	Verity Central	2.5.1	HRT-Verity-2.5
5.	Verity User Management	2.5.0	HRT-Verity-2.5
6.	Verity Election Management	2.5.0	HRT-Verity-2.5
7.	Verity Desktop	2.5.0	HRT-Verity-2.5
8.	Verity Scan	2.5.1	HRT-Verity-2.5
9.	Verity Touch Writer with Access	2.5.1	HRT-Verity-2.5
10.	Verity Controller	2.5.1	HRT-Verity-2.5
11.	Verity Touch	2.5.1	HRT-Verity-2.5
12.	Verity Touch with Access	2.5.1	HRT-Verity-2.5
13.	Verity Touch Writer Duo	2.5.1	HRT-Verity-2.5
14.	Verity Touch Writer Duo Standalone	2.5.1	HRT-Verity-2.5

System Summary

Overview. The Verity system comprises:

(a) software components that run under Windows 10 on commercial-off-the-shelf (COTS) computer systems (1-7 above)
(b) devices for the polling place (8-14 above), and
(c) COTS components (such as computers, printers, and scanners).

Security

Chain of Custody. To verify that components we tested are the same as that certified by the Election Assistance Commission (EAC), the Secretary of State obtained the images directly from the EAC. Hart delivers its software components to customers on hard drives and its firmware components on memory cards known as CFAST. (CFAST is a newer version of Compact Flash memory, which is widely used in digital cameras. CFAST is short for Compact Fast, since CFAST is faster than Compact Flash.)

The hard drives and CFAST cards delivered by Hart require no software or firmware installation; once they have been inserted into the computer or other device, it is only necessary to switch on the power. Since the EAC sent the same kind of media Hart would give to customers, the examiners did not need to observe any detailed installation procedures.

There is also a procedure that allows the customer to verify that the software has not been tampered with. This is done by creating a manifest containing hashes of the files that the system comprises. The hashes are compared with those on a manifest downloaded from the National Software Reference Library. If the hashes are the same, the files are also. We compared the hash codes and verified that we examined the same products as the EAC.

Verity Keys are USB drives used to provide extra security (in addition to user IDs and passwords) to certain parts of the Verity system. They contain no election data and are used solely as tokens to allow access only to people who have the appropriate Verity Key and passcode.

Verity Keys are not used in polling places, where only a six-digit numeric passcode is needed. The passcodes can be different for different operations, such as Open Polls, Close Polls, and spoil a ballot.

There is some security risk in the polling places because the passcodes are the same throughout an election across all precincts for all voting stations and other precinct devices.

For security in the central-count office, where Verify software is run under Windows 10, Verity workstations are run in *kiosk mode,* denying access to the operating system to anyone who does not have a special passcode available only from Hart support and valid for only one day.

Election Setup

The Hart Verity workstation software (Verity Data, Verity Build, etc.) can

(a) create an election definition (containing races, candidates, ballot styles, etc.),

(b) proof the election,

(c) print ballots or create PDF files to send to a printer,

(d) create Verity Keys, and

(e) create *vDrives*, which convey election information to the voting devices and scanners.

vDrives are USB drives that are easily distinguishable from Verity Keys by shape and color. All vDrives contain the entire election definition and any vDrive for the election can be used to convey the election definition to any Verity device. For example, vDrives are used in polling places to initialize devices such as the Verity Touch, Verity Scan, and Verity Touch Writer Duo. vDrives for a given election all contain exactly the same data at first, for ease of creation and handling, but once a vDrive is used to initialize a device for the election, a unique ID is written on the vDrive, so it can be used only with that device and every use of that vDrive can be traced in the audit logs.

When voting is over, the vDrives convey cast-vote records and logs to the counting location while a duplicate copy on the CFAST remains in the machine. All results are in clear text, but digitally signed so that their authenticity can be verified. Results are stored on vDrives in random order, to protect voter privacy. Should a vDrive have an invalid signature (or a signature from a different election), it will not be accepted.

Voting

Voting may be done (a) by hand-marking a paper ballot, (b) by voting on a Verity Touch, a direct-recording electronic (DRE) voting station, which records votes directly on both its vDrive and CFAST, or (c) by using either the Verity Touch Writer or the Verity Touch Writer Duo. The last two allow the voter to make selections on a touch screen and then print a marked ballot with those selections; they do not record the votes, except (of course) on the marked ballots that they print. The marked ballot from the Touch

Writer looks like a traditional hand-marked ballot, while the ballot created by the Touch Writer Duo (called a PVR, for printed vote record) is printed in plain text that can be directly read by optical character recognition, with a hash in a QR code to detect any errors.

Voting can be done using the touch screen, but there are also accessible devices: audio, paddles, and sip-and-puff. Accessibility support was tested by the Secretary of State and is not covered by this report.

The voting devices seemed well-designed and easy to use, reducing the burden of both voters and poll workers. They present one race at a time to the voter, which in my opinion is the best method. The messages were very understandable. I also spot-checked the Hart documentation for administrators and poll workers and found it understandable as well. It is still a formidable task to run an election, but good documentation and clear messages ease the burden significantly.

The Touch Writer does have the disadvantage that each voter must be authorized by a poll worker who must physically walk to the Touch Writer, enter a password to gain access, and then select the voter's precinct. In my opinion, this procedure is awkward and requires a lot of poll-worker time. However, a single Touch Writer in every polling location would provide access to disabled voters.

The Touch Writer Duo does not have this disadvantage, because each voter is given a piece of thermal paper with a five-digit access code that controls ballot selection. Since voters on the Duo are also given a blank sheet of ballot stock to record their choices, there is a small inconvenience, because they must enter their access code while holding both the blank sheet and the slip of paper containing the access code.

The Verity Controller controls voting at a group of Verity Touch or Touch Writer Duo stations. It issues the five-digit access codes that a voter must enter to begin voting.

Hart also offers Verity Scan, which can scan ballots in the polling place and store cast-vote records for later tabulation.

Tabulation, Reporting, and other Central Activities

Verity Central reads vDrives with results from the polling places and does ballot scanning, produces reports, and provides audit data. It can resolve issues and process write-ins and provisional votes, both for ballots it scanned and for those scanned in the precinct and then transported on a vDrive. Verity Central does *not* tabulate votes.

Verity Count tabulates the votes (stored in cast-vote records that came from a vDrive) and produces reports. Like Verity Central, it can also resolve issues and process write-ins.

Security

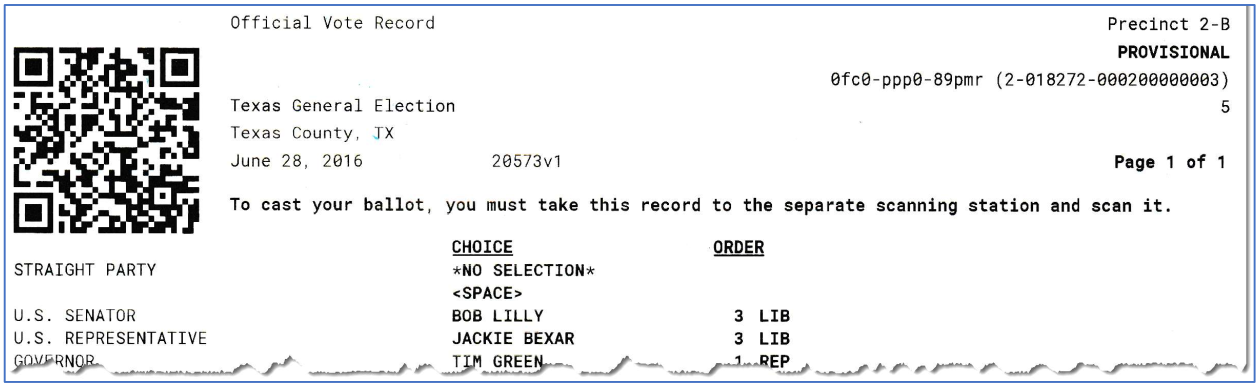
Throughout the devices, security is enhanced using modified ports and cables to prevent attacks employing off-the-shelf components. Also, V-drives are digitally signed to prevent tampering. On workstations they use Bitlocker as an added layer of encryption and they only allow software that is on their whitelist (approved list) to be installed.

Suggestions

1. **Batteries in Equipment for Curbside Voting.** Hart has a carrier for the TouchWriter (called Verity Duo Go) that allows it to be used for curbside voting. When curbside voting is complete, it would be helpful to have a message reminding the pollworker to plug the unit back into AC power, to make sure the battery remains charged.

2. **Suggestions for the Ballots**
   a) Underlining. Thank you for using boldface for the very important words "To cast your ballot, you must take this record to the separate scanning station and scan it." It is very well worded. However, as you can see the boldface is not very noticeable. I suggest underlining it.

Now:



Official Vote Record

Precinct 2-B
PROVISIONAL
0fc0-ppp0-89pmr (2-018272-000200000003)
5

Texas General Election
Texas County, TX
June 28, 2016 20573v1

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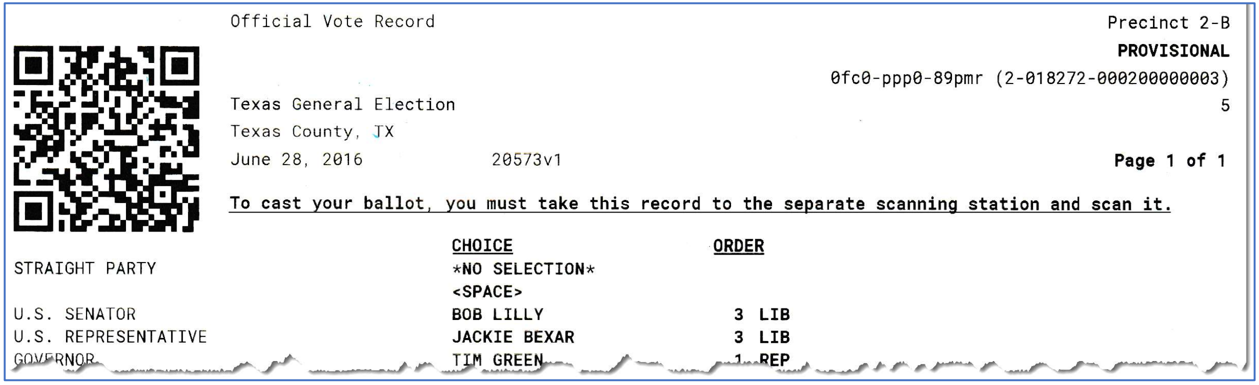
To cast your ballot, you must take this record to the separate scanning station and scan it.

	CHOICE	**ORDER**
STRAIGHT PARTY	***NO SELECTION***	
	<SPACE>	
U.S. SENATOR	**BOB LILLY**	**3 LIB**
U.S. REPRESENTATIVE	**JACKIE BEXAR**	**3 LIB**
GOVERNOR	**TIM GREEN**	**1 REP**

Proposed:



Official Vote Record

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0fc0-ppp0-89pmr (2-018272-000200000003)
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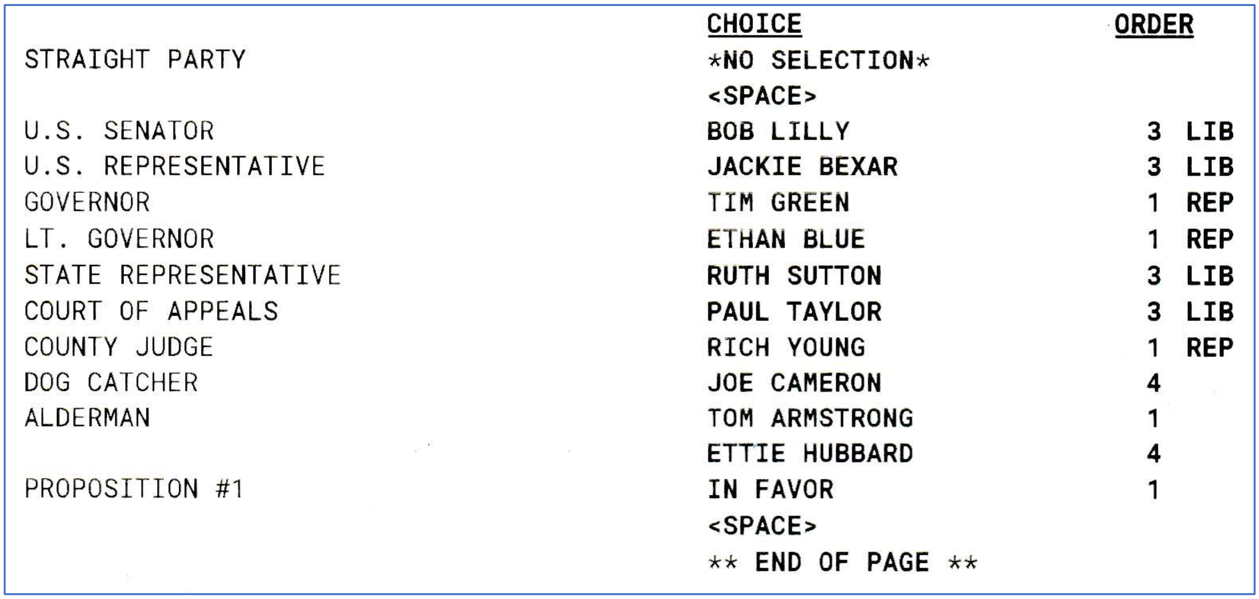
To cast your ballot, you must take this record to the separate scanning station and scan it.

	CHOICE	**ORDER**
STRAIGHT PARTY	***NO SELECTION***	
	<SPACE>	
U.S. SENATOR	**BOB LILLY**	**3 LIB**
U.S. REPRESENTATIVE	**JACKIE BEXAR**	**3 LIB**
GOVERNOR	**TIM GREEN**	**1 REP**

b) Move the word “<SPACE>” (in the “Choice” column) a little to the right, as shown below. If this were done, possibly by something as simple as inserting a few space characters to the left of the word “<SPACE>”, it would be easier for voters to scan the “Choice” column and understand it.

Now:



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                                          CHOICE                ORDER
STRAIGHT PARTY                            *NO SELECTION*
                                          <SPACE>
U.S. SENATOR                              BOB LILLY                3  LIB
U.S. REPRESENTATIVE                       JACKIE BEXAR             3  LIB
GOVERNOR                                  TIM GREEN                1  REP
LT. GOVERNOR                              ETHAN BLUE               1  REP
STATE REPRESENTATIVE                      RUTH SUTTON              3  LIB
COURT OF APPEALS                          PAUL TAYLOR              3  LIB
COUNTY JUDGE                              RICH YOUNG               1  REP
DOG CATCHER                               JOE CAMERON              4
ALDERMAN                                  TOM ARMSTRONG            1
                                          ETTIE HUBBARD            4
PROPOSITION #1                            IN FAVOR                 1
                                          <SPACE>
                                          ** END OF PAGE **
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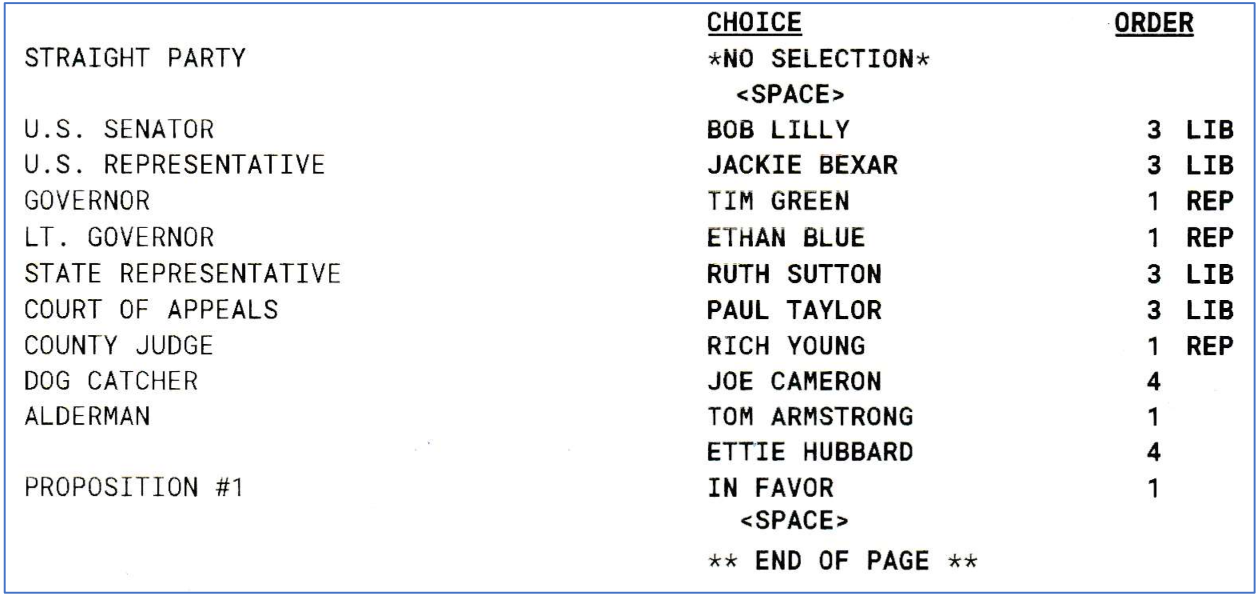
Proposed:



```
                                          CHOICE                ORDER
STRAIGHT PARTY                            *NO SELECTION*
                                            <SPACE>
U.S. SENATOR                              BOB LILLY                3  LIB
U.S. REPRESENTATIVE                       JACKIE BEXAR             3  LIB
GOVERNOR                                  TIM GREEN                1  REP
LT. GOVERNOR                              ETHAN BLUE               1  REP
STATE REPRESENTATIVE                      RUTH SUTTON              3  LIB
COURT OF APPEALS                          PAUL TAYLOR              3  LIB
COUNTY JUDGE                              RICH YOUNG               1  REP
DOG CATCHER                               JOE CAMERON              4
ALDERMAN                                  TOM ARMSTRONG            1
                                          ETTIE HUBBARD            4
PROPOSITION #1                            IN FAVOR                 1
                                            <SPACE>
                                          ** END OF PAGE **
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Concerns

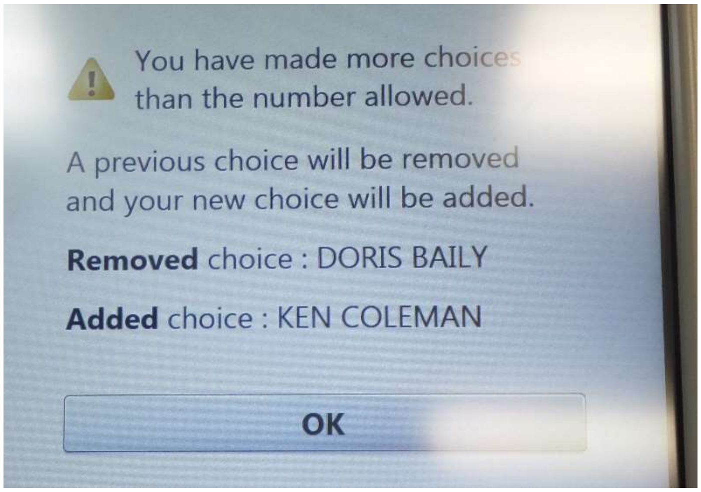
1. **Hash Code Verification.** There are several problems with the hash-code verification process.

    a. The names of the files to be verified using hash codes is read from a manifest file, which creates a risk if the manifest is not faithfully updated. It would be easy to overlook maintenance of the manifest; for example, some file lists in the Knowledge Base are out of date. Of course, not all files can be hashed and matched, because some are changed dynamically. However, it would be much better to maintain a list of the files ***not*** to be hashed. All DLL and EXE files should always be hashed, because they are never dynamic.

    b. For the Verity Controller, Touch, and Touch with Access, obtaining the hashes requires holding down a blue button for quite a long time. This is not intuitive, and its awkwardness creates a strong temptation to skip this important step.

    c. Hart recommends that the hashes be compared visually, which is difficult and error prone. As above, there is a temptation to skip this step. They should be automatically compared, although the individual hashes should be preserved for auditing.

2. **Multi-select Overvotes.** This affects all the Touch devices. Consider a race where one can vote for multiple candidates – say the voter can choose three of seven. If the voter has selected three candidates and tries to select a fourth, the TouchWriter will automatically deselect the first candidate selected, and give a message like the one in the photo to the right.



You have made more choices than the number allowed.

A previous choice will be removed and your new choice will be added.

Removed choice : DORIS BAILY

Added choice : KEN COLEMAN

Although the candidate who was deselected is unlikely to be the one the voter would have deselected, the voter can fix the problem. In the example, KEN COLEMAN is most likely the voter's last (fourth) choice, simply because the voter selected him last. In this case the voter can, after clearing the error message, deselect KEN COLEMAN and reselect DORIS BAILY. Note that it's not a good idea to simply clear the message and select DORIS BAILY, because the device might again choose the wrong candidate to deselect.

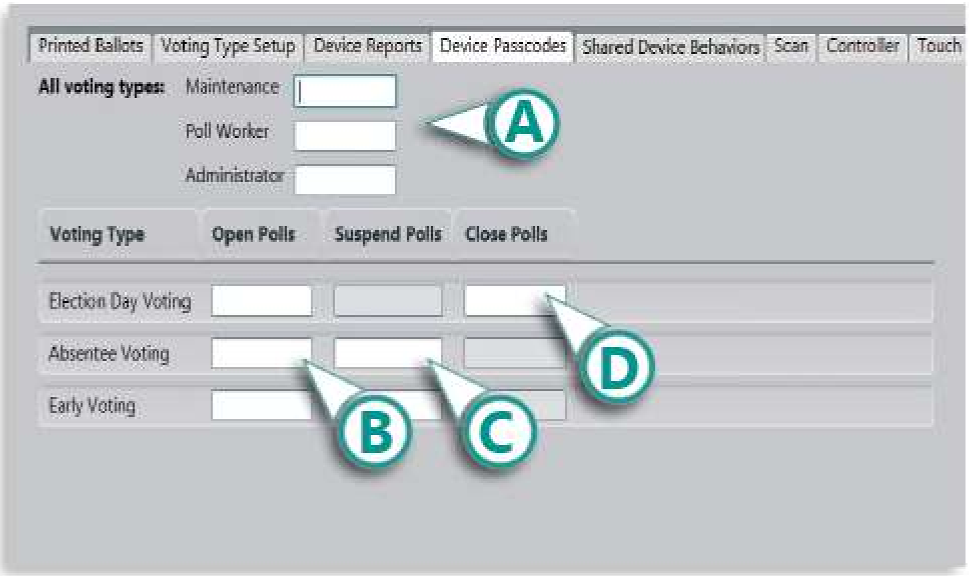
I believe this is confusing, but acceptable because the voter can always recover and because races with multiple selections are rare.

As I wrote in a previous report, I would much prefer for the machine to refuse the overvote (KEN COLEMAN) and tell the voter to deselect a candidate before selecting another.

3. **Precinct passcodes are the same.** The passcodes are the same for all voting stations and other precinct devices throughout the entire election, although they are different for different types of tasks.

   Since the same set of passcodes must be given to many people (at least one person at every voting location), it is imperative not to distribute the passcodes until just before the election and that different passcodes should always be used for training.

   A good place to include this information would be in the *Verity Administrator's Guide: Build*, on the "Configure Settings" tab, step 4.



Conclusion

Although my concerns should be addressed in future versions, I recommend certification of the Hart Verity system as detailed on the first page of this report.