COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF STATE

EXAMINATION RESULTS OF THE ELECTION SYSTEMS AND SOFTWARE, INC. iVotronic TOUCHSCREEN VOTING SYSTEM WITH UNITY SOFTWARE

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EXAMINATION OF THE
ELECTION SYSTEMS AND SOFTWARE, INC. iVotronic
TOUCHSCREEN VOTING SYSTEM WITH UNITY SOFTWARE

A REPORT BY THE SECRETARY
OF THE COMMONWEALTH OF PENNSYLVANIA

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 Election Code, 25 P.S. § 3031.5, requires all electronic voting systems to be examined and approved by the Secretary of the Commonwealth before use in any election in Pennsylvania.

Upon the request for an examination of the iVotronic Direct Recording Electronic Voting System, version 9.1.2.0 with Unity, Election Management Software, version 3.0, (hereinafter referred to as the “System”) made by Election Systems and Software, Inc. (ES&S), the Department of State (Department) scheduled an examination of the System for November 16 and 17, 2005. The Department has received confirmation from SysTest Labs, a federally recognized independent testing authority (ITA) that the System’s hardware and software have successfully completed qualification testing in compliance with the Federal Election Commission 2002 Voting System Standards.

The Secretary of the Commonwealth retained Michael Ian Shamos, Ph.D., J.D., as a consultant to conduct an electronic voting system examination on November 16 and 17, 2005. Harry A. VanSickle, Commissioner of the Bureau of Commissions, Elections and Legislation; Kenneth A. Rapp, Deputy Secretary for Regulatory Programs; Larry Boyle, Deputy Chief Counsel; Chet Harhut, HAVA Administrator; Lindsley Houser, HAVA Assistant; Jim Criss, Bureau of Management Information Systems and Jonathan Marks, Chief of the Division of Elections/Precinct Data; represented the Secretary of the Commonwealth.

II. iVotronic TOUCHSCREEN VOTING SYSTEM WITH UNITY SOFTWARE

Presented for certification was the iVotronic, version 9.1.2.0, currently updated to version 9.1.3.0 due to a resubmission to the ITA. The vendor also presented its election management software, Unity, version 3.0.

The following paragraphs in this section briefly describe the functions of the System as summarized by the consultant.
iVotronic Electronic Voting System

Submitted for certification was the iVotronic with firmware 9.1.2.0. This is a touch-screen Direct Recording Electronic ("DRE") machine with an onboard Voter Verifiable Paper Audit Trail ("VVPAT") printer and battery backup power supply. It is programmed for an election through the use of a supervisor Personalized Electronic Ballot ("supervisor PEB") that is inserted in a slot in the machine. Data is transferred from the PEB to the iVotronic through an infrared ("IrDA") interface.

After the polls are opened, a district election official activates the machine for voting by inserting and removing a voter Personalized Electronic Ballot ("PEB"). The ballot style appropriate for that voter is then displayed on the screen, and the voter may begin voting in the usual touch-screen DRE manner. After a ballot is cast, the machine is deactivated and no other vote can be cast until another voter PEB is inserted and removed.

Multiple iVotronic units may be used in a polling place. They are not networked, but ballots from the entire polling place can be accumulated on a single PEB for tabulation on any one of the machines. Because of the integrated VVPAT printer, zero tapes are produced on a separate unit called a "communications pack." This device is a printer with communication interfaces and a modem for uploading results. To produce a zero tape, the communications pack is connected to the iVotronic temporarily, prior to when the polls are opened. The zero tape is printed on the pack. The pack is then connected to the next iVotronic, etc. until zero tapes for all iVotronic machines have been produced. In another operating mode, the pack produces a combined tabulation for all of the machines at a polling place.

At the close of the polls, a summary tabulation report can be printed out on the attached VVPAT printer or on the communications pack. In addition, ballot images can be written to a PEB, which can be transported to election central for accumulation.

The iVotronic is accessible to visually impaired voters through an audio interface and Americans with Disabilities Act (ADA) scroll buttons and is also accessible to wheelchair-bound voters.

Unity Software

Unity is a set of software programs that operate collectively to define elections, program tabulating machines, lay out ballots and accumulate results. Unity may be used with multiple devices within the same jurisdiction (e.g. DREs for in-precinct voting and optical scan for absentee). Unity is designed to support all ES&S products and permits several different types of voting equipment to be used in the same county.

Unity 3.0 runs under Windows XP and includes the following components:

- Election Data Manager (EDM) version 7.4.3.0
- Image Manager (IM) version 7.4.1.0
• iVotronic Image Manager (IVIM) version 2.0.1.0
• Hardware Programming Manager (HPM) version 5.2.2.0
• Election Reporting Manager (ERM) version 7.1.1.0
• Audit Manager version 7.3.0.0

The Audit Manager is used to set up and administer accounts and passwords. Even though a login is required to bring up Windows XP, a separate login can be required to access various Unity components. Audit Manager maintains a database of all authorized user IDs and passwords. It also produces audit log reports of significant election events. For example, it is able to list every event and who performed it so that irregularities are detected. To do this, it reads audit log files that are updated by other Unity programs.

Election Data Manager (EDM) is used to set up elections, from the geographic structure of jurisdictions, as well as to parties, races, candidates and issues. It is designed to support elections in numerous states, and therefore allows multiple sets of options for defining elections and their characteristics. Some information is designed to be entered once and edited infrequently, such as the geographic structure of a county and its election districts. Other information, such as candidate names, will change in every election.

The principal output of EDM is a set of files defining ballot styles and various election parameters. The “Ballot Styles” files are read by other programs in the Unity suite to perform different functions, such as setting up tabulating equipment to recognize different ballot styles and to count them properly.

After EDM has been run, two different Image Managers are used to define particular ballot layouts. Image Manager (“IM”) is for optical scan ballots and iVotronic Image Manager (“IVIM”) is for DREs. The layout information is used to update the Ballot Styles file with precise measurements indicating where candidate ovals appear on the ballot, for example. IM is able to produce camera-ready files from which optical scan ballots can be printed.

Once the Ballot Styles database has complete information, Hardware Programming Manager (“HPM”) is able to create media with ballot program coding for the Model 100 and Model 650 optical scan units.

HPM understands tabulating options and its output is needed so that vote totals can be reported properly from various tabulators. The Election Reporting Manager (“ERM”) receives ballot data from the tabulators and tabulation parameters from HPM so it can produce jurisdiction-wide totals.
III. EXAMINATION PROCEDURES AND RESULTS

At the examination conducted on November 16 and 17, 2005, the consultant tested the System for the statutory requirements specified in section 1107-A of the Election Code, 25 P.S. § 3031.7. The vendor demonstrated the setup, opening of the polls, voting, closing of the polls and election night tabulation features of the System. The consultant and the Department representatives asked questions of the vendor and requested demonstrations of various features before conducting the Pennsylvania Standardized Test (Test). The first Test is a set of 12 Municipal Election ballots. The second Test is a set of 12 Municipal Primary ballots (6 Democratic and 6 Republican). Both Tests are designed to ensure the electronic voting System’s compliance with the Election Code.

Although the System accurately tabulated the results of the Test, based on the results of the examination, including the answers to questions provided by the vendor and the advice provided by the Department’s consultant, the Department offers the following observations, concerns and conditions for the System.

The Zero Tape

Section 1107-A(16)(v) of the Election Code, 25 P.S. § 3031.7(16)(v), provides that “[i]f the voting system is of a type which provides for the computation and tabulation of votes at the district level, the district component of the automatic tabulating equipment shall include the following mechanisms or capabilities: … (v) It shall be equipped with an element which generates a printed record at the beginning of its operation which verifies that the tabulating elements for each candidate position and each question and the public counter are all set to zero and with an element which generates a printed record at the finish of its operation of the total number of voters whose ballots have been tabulated, the total number of votes cast for each candidate whose name appears on the ballot, and the total number of votes cast for, or against, any question appearing on the ballot.”

The iVotronic is a district level system, and the “district component” must be equipped with an element that generates the required printed record. While iVotronic with the VVPAT produces totals at the finish, it does not produce a zero record (zero tape) at the opening of the polls. To do that, the communications pack must be connected to each voting unit in turn, so that a zero tape is produced on the printer attached to the pack. In this configuration, the district component is not equipped with an element that generates the zero tape, but since a zero tape is produced by each individual voting unit by the district component, the Department believes that this meets the requirements found in the statute. However, the Secretary is recommending that future versions of the iVotronic be reconfigured to produce an onboard zero tape at each machine. The Secretary reminds counties that they must print, sign and post each zero tape at the opening of the polls, pursuant to the requirements found in sections 1110(g) of the Election Code, 25 P.S. § 3031.10(g), and 1209(b)(1), 25 P.S. § 3049(b)(1).
The VVPAT

The iVotronic contains a VVPAT printer on all machines. In this instance, ES&S has implemented a "continuous roll" VVPAT, meaning that each ballot image is captured in the order in which it is voted on a continuous roll. The use of this type of VVPAT allows a complete violation of voter privacy.

The "numbered list of voters" is a list of voters listed in the order in which they voted. This document is considered public information and is available for inspection by the public at each county board of elections upon request. Furthermore, nothing prevents a volunteer authorized by a candidate or political party as a "watcher" from remaining all day in the polling place and recording the order of voters, and, if necessary, the specific machine on which they voted. Because the ballot images are recorded on paper in the order in which they are voted, merely comparing each ballot image with the numbered list of voters will reveal every voter's choices in a given precinct. Such a comparison could easily be made in the event of a recount. This is a direct violation of Article VII, Section 4 of the Pennsylvania Constitution, which mandates that “[a]ll elections by the citizens shall be by ballot or by such other method as may be prescribed by law; Provided, That secrecy in voting be preserved.” This also violates section 1107-A(1) of the Election Code, 25 P.S. § 3031.7(1), which states that no electronic voting system can be approved unless it “provides for voting in absolute secrecy and prevents any person from seeing or knowing for whom any voter, except one who has received or is receiving assistance as prescribed by law, has voted or is voting.” Due to these requirements, the iVotronic continuous roll VVPAT must be disabled prior to being delivered to counties because it violates the Pennsylvania Constitution and the Election Code.

Under-vote Message

A voter who under-votes on an iVotronic system will be warned on the summary screen that he or she has under-voted one or more races. The Department believes that this message may be ignored and the under-voted ballot be cast anyway. The Secretary recommends that a prominent under-vote warning be given to the voter before he or she advances to a new screen.

Physical Security of iVotronic

Several aspects of the iVotronic design have negative security implications. Failure to incorporate strong security controls violates section 1107-A(12) of the Election Code, 25 P.S. § 3031.7(12), relating to ballot security procedures.

First, the compact flash card, which can contain audio ballots and long text ballots, is inserted in the iVotronic at the polling place. This raises the question by what secure mechanism, if any, it gets to the polling place, and what prevents substitution of a different flash card. While there are various consistency checks performed between the flash card and the PEB, it is accepted practice to load ballot programming at the warehouse and seal it in place in the machine, rather than resorting to the relatively uncontrolled conditions at a polling place. Pennsylvania counties
purchasing the iVotronic must be instructed to install iVotronic flash cards at the
warehouse and seal them into the voting units.

Various cables are connected to the iVotronic at its top edge as viewed by the voter. These
connections are open and unsealed, and a voter can easily disconnect the connectors. While such
tampering would probably be apparent to the poll worker, no such temptation should be present.
**The Secretary recommends all user-tamperable connections on iVotronic must be removed or
protected with a locking mechanism.**

The communications pack has modem upload capability so results at the close of polls can be
transmitted to a central location. It is common for vendors to add various communication
interfaces to their devices for a variety of purposes, including uploading of vote totals and
downloading of software patches. While the Pennsylvania Election Code does not deal
specifically with modems and other particular communication methods, the general requirement
of security in section 1107-A(12) of the Election Code, 25 P.S. § 3031.7(12), requires the
Department to consider these devices. The Department has always taken the position, based on
the statute, that modem communication of results, either official or unofficial, is impermissible.
Doing so requires connection of uncertified equipment (the telephone instruments and network)
to certified equipment (the voting machines and tabulators). The resulting configuration is
uncertified and therefore cannot be used in elections. **Therefore, Pennsylvania counties
purchasing the ES&S System may not use the ES&S provided modem upload
capability to transmit official or unofficial election results.**

**Security of Unity Software**

The various modules of Unity can be set to either require passwords or not to access them.
Passwords are important for security and auditability. Failure to incorporate strong passwords
violates section 1107-A(12) of the Election Code, 25 P.S. § 3031.7(12), relating to ballot
security procedures. Additionally, the Audit Manager records the identification of any user
who invokes various functions, such as changing vote totals. If the user is not required to log in,
the Audit Manager cannot record his user ID, and it will not be possible to identify the person
who made a change. **The Secretary recommends that passwords be required for all Unity
modules.**

Even when passwords are required, Unity, as delivered, recognizes global default passwords.
Passwords that are set at the factory may be used with any iVotronic unit in the country. While
the vendor recommends changing these passwords, this recommendation does not occur until
page 105 of the Unity manual. **The Secretary requires that counties change the default
passwords upon receipt of this System. Furthermore, the Secretary recommends that
counties continue to change their passwords after every election.**

Unity runs on an ordinary Windows laptop or desktop. Such a machine could be connected to
the Internet, have a wireless card or Bluetooth interface, or be attached to a local or wide area
network. All of these represent security risks of varying risk. Unity makes no effort to restrict,
or even monitor, these possible connections. **The configuration of the Unity computer is
therefore uncontrolled and unauditible. That is, after an election, it is impossible to determine what modifications might have been made by an intruder, a virus, spyware or other species of malicious code. In fact, if the computer on which Unity runs has been connected to the Internet for even a brief time, there can no longer be any assurance that the system has not been corrupted.

If the vendor is unwilling to impose configuration restrictions through software, the Commonwealth must do so by other means. One way is to compel the jurisdictions to run Unity exclusively on a standalone machine. This causes no hardship. If it is necessary on election night to report results to the press using a website, interim results can be transferred to a web server by flash drive or floppy disk. The Secretary requires that Unity be operated as a standalone system without network connection, local or otherwise.

The consultant made various efforts to tamper with election files, including ballot programming and results files. While files could be changed, a by-product of the Windows operating system, it was not possible to make any useful changes to the files. That is, the system detected that changes had been made and refused to read or process the modified files.

**Illegal Options Within Unity**

Unity is a very complex system because it must handle the huge variety of voting practices encountered throughout the United States. It is unrealistic for a vendor to support numerous distinct versions of its system for each state, so ES&S has taken the approach of building all possible election options into a single system.

Unfortunately, the number of options that can be chosen in setting up an election is large. Some options, such as a straight party race, are mandatory in Pennsylvania. Others, such as ballot rotation, are illegal. Yet others, such as the sort sequence for tabulation reports, are completely optional to a jurisdiction. For some options, it is not at all clear whether they should be chosen or not.

One option that EDM allows is for a race to be eliminated from the ballot completely if no candidates are running. This is illegal in Pennsylvania pursuant to section 1107-A(5) of the Election Code, 25 P.S. § 3031.7(5), requiring that the office must be shown, and there must be enough write-in spaces provided to vote for the maximum number of allowed candidates. EDM offers an “Eliminate Write-Ins” option.

Yet another option is to allow the voter to cast his or her ballot without viewing a summary page. This should not be chosen because it eliminates any under-vote warning and clearly increases the risk of error. Another option is “allow over-vote,” which is not only illegal in Pennsylvania pursuant to section 1107-A(6) of the Election Code, 25 P.S. § 3031.7(6), but in all federal elections under section 301(a)(1) of the Help America Vote Act (HAVA), 42 U.S.C. § 15481(a)(1).
The Unity manual is 265 pages long. In it, the term “straight party” occurs 114 times. The word “Pennsylvania” occurs only once, describing an option for printing absentee ballots. There are no instructions on how to vote using the Pennsylvania method, for example, nor any indication that ballot rotation must not be chosen. Legal setup of an election is entirely up to the training and experience of the programmer at the county board of elections.

Not only does the word “Pennsylvania” not appear in the appropriate place in the Unity manual, it also does not appear on Unity setup screens. Some options are not explained in the documentation at all. One of these options is called “straight party inclusive logic.” Apparently required in Indiana, but nowhere else, this option causes the machine to select candidates automatically on behalf of the voter if he or she has not voted for the full number of candidates allowed in an office.

Some setup choices that appear innocuous can cause anomalies that might evade proofreading. For example, in the primary election that was set up by the vendor in advance of the examination, the wrong font size was selected for write-in names. The ballot face looked completely normal. However, when a write-in was entered for “Rose Johnson,” the font was so large that only the letters “ROSE” appeared on the ballot and the review screen. This is a type of error that might not be noticed until an election is actually in progress.

To avoid the aforementioned concerns, the Secretary requires that a checklist be prepared by ES& S, in consultation with the Department, to be furnished to any Pennsylvania county upon delivery of the voting System, detailing the selectability of each option when setting up an election.

IV. CONDITIONS/RECOMMENDATIONS FOR CERTIFICATION

Conditions

1. The iVotronic continuous roll VVPAT must be disabled prior to being delivered to Pennsylvania counties, because it violates the Pennsylvania Constitution and the Election Code.

2. Pennsylvania counties purchasing the ES&S System may not use the ES&S provided modems to transmit official or unofficial election results.

3. Pennsylvania counties must change the default passwords upon receipt of this System.

4. Unity must be operated as a standalone system without network connection, local or otherwise.

5. Pennsylvania counties purchasing the iVotronic must be instructed to install iVotronic flash cards at the warehouse and seal them into the voting units.
6. A checklist must be prepared by ES&S, in consultation with the Department, to be furnished to any Pennsylvania county upon delivery of the System, detailing the selectability of each option when setting up an election. (The issues are addressed in Section III, the subsection entitled Illegal Options within Unity)

Recommendations

The Secretary suggests the following recommendations for future versions of the iVotronic:

1. The Secretary recommends that the iVotronic be reconfigured to produce an onboard zero tape at each machine. The Secretary reminds counties that they must print, sign and post each zero tape at the opening of the polls, pursuant to the requirements found in sections 1110(g) of the Election Code, 25 P.S. § 3031.10(g), and 1209(b)(1), 25 P.S. § 3049(b)(1).

2. The Secretary recommends all user-tamperable connections on iVotronic must be removed or protected with a locking mechanism.

3. The Secretary recommends that passwords be required for all Unity modules.

4. The Secretary recommends that counties continue to change their passwords after every election.

5. The Secretary recommends that a prominent under-vote warning should be given to the voter before he or she advances to a new screen.

V. CONCLUSIONS

As a result of the examination conducted on November 16 and 17, 2005, and after consultation with the Department’s staff and consultant, certification of the iVotronic electronic voting system with Unity election management software is hereby awarded by the Secretary of the Commonwealth for use in elections in the Commonwealth of Pennsylvania in accordance with section 1105-A of the Election Code, 25 P.S. § 3031.5, provided it is implemented with the conditions listed in section IV of this report. The System will accommodate no more than 300 voters per unit.

In addition, pursuant to the Directive on Electronic Voting Systems issued by the Secretary of the Commonwealth on July 22, 2005 and to section 1105-A(d) of the Pennsylvania Election Code, 25 P.S. § 3031.5(d), this certification is valid only for the voting system examined on November 16 and 17, 2005. If the vendor makes any changes to the system subsequent to November 16 and 17, 2005, it must immediately notify both the Pennsylvania Department of State and the relevant
federal IT'As or their successors. Failure to do so may result in the decertification of this voting System in the Commonwealth of Pennsylvania.

All jurisdictions implementing this System for use must comply with the conditions and requirements found in this report and any directives issued by the Secretary of the Commonwealth regarding the use of this System, in accordance section 1105-A(a-b) of the Pennsylvania Election Code, 25 P.S. § 3031.5(a-b).