

Assessment of Voting System Technology Report

Prepared for:

**Colorado Department of State
And
Colorado Voter Access and Modernized Election
Commission**

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1 Executive Summary

SLI Global Solutions (SLI) was contracted by the Colorado Department of State and the Colorado Voter Access and Modernization Election Commission to conduct an assessment of voting systems.

This assessment looks at voting systems from several points of view, which include the systems currently certified by the State of Colorado (State), systems certified by the U.S. Election Assistance Commission (EAC) but not by the State, as well as other systems certified by neither the EAC nor the State. In looking at the systems not certified by the EAC nor the State, we consider traditional voting systems as well as non-traditional systems.

There are 5 systems currently certified by the State and in use by the 64 counties that comprise Colorado. These systems were originally federally qualified under the National Association of State Election Directors (NASD) in the 2006 time frame. The discussion below looks at the age of the components of the systems, as well as issues found in the field.

There are voting systems that are currently certified by the U.S. Election Assistance Commission (EAC), but not certified for use in Colorado. While there are many systems certified by the EAC a significant number of the systems utilize aged components that SLI believes should preclude them from consideration as a long term solution for the voting technology needs for the State.

The voting systems that are certified by neither the EAC nor the State can be broken into 2 sub categories, traditional and non-traditional voting systems. The traditional voting systems are systems that use technologies commonly seen in currently fielded voting systems, and thus are immediately eligible for certification by the EAC and then the State. The non-traditional systems are voting systems that utilize new technologies that have not yet been implemented in currently certified voting systems. This can include new types of hardware as well as modes of transmission of ballot styles and vote data.

SLI also details projected processes and timelines for State certification of each of the above mentioned voting system categories.

This report also looks at the county's need for replacement of voting systems, including underlying issues that make the need more imminent than some counties currently believe to be the case. Additionally, the report looks at what types of systems will be congruent with the mail-in election model, as well as what considerations should be taken for a uniform voting system. With the counties of Colorado having such variation in terms of population size, geography and voting preferences, there are many considerations to keep in mind when determining a uniform voting system. Timing of implementation of a new system also needs to be considered in terms of scheduled elections as well as which counties would be best suited for an initial rollout, as part of a phased implementation.

Estimates of the size of a new uniform voting system are reviewed as well as potential funding sources for a new system. The sizing is based on the HB13-1303's mail-in election model and what counties are projecting to need for the mail-in election model,

which includes the new vote center implementation. With fewer locations for conducting in-person voting, the equipment needs are greatly reduced.

As part of the data gathering process for this report, SLI conducted a 2 phase survey of the counties. First, a written survey was sent to all the counties asking a variety of questions dealing with the topics of this report. Forty-three counties responded. Second the counties were asked to participate in a telephone interview that acted as a followup to the written survey. Twenty eight counties participated in the telephone survey. The representative sampling size was determined to be significant. The sample for both phases covered the range of the State. Each part of the State was represented not only in terms of location but also in terms of population size, which ranged from very small to very large, as well as in terms of geographical size from some of the smallest size-wise to some of the largest. Differences in terms of technical abilities were also represented. Some counties are well staffed with trained personnel, while other counties have only part time staff that are also tasked with other non-election duties.

The questions and a summary of each are listed within this report. The raw data results are included as attachments to the report.

2 Certification of Voting Systems

This section provides information regarding the overall certification status of voting systems that may be of interest to the State of Colorado. The following topics are addressed:

1. Analysis of voting systems currently in use in Colorado
2. Availability of voting systems that are certified by the EAC but not yet certified in Colorado
3. The process and timeline for certifying voting systems that are not currently certified by Colorado, the EAC, or any other State.

Attachments to this document include:

- Attachment A – UVS County Written survey
- Attachment B – UVS County Telephone Interviews Survey

2.1 Analysis of voting systems currently in use in Colorado

The State of Colorado currently has five systems that have been tested against the 2002 VSS and are certified for use in Colorado. These systems are:

- ES&S Unity 3.0.1.1
- Hart System 6.2.1
- Hart System 6.0
- Premier GEMS 1.18.24

- Sequoia WinEDS 3.1.074

2.1.1 ES&S Unity 3.0.1.1

Unity 3.0.1.1 was originally qualified by NASED in August 2006.

A State of California “Red Team” voting system write-up with information about this version of Unity can be found at:

<http://www.sos.ca.gov/voting-systems/vendors/ess/unity-3011-red-team.pdf>

The review identified several issues that have been found throughout the system:

- None of the data stored on the M100 tabulator’s PCMCIA memory card is encrypted, which enables a potential attacker to analyze and potentially modify data
- Various functionality can be compromised by unauthorized access to Audit Manager by cracking the password
- Many election day devices have locks and seals susceptible to compromise

In addition to the issues cited in the California report, several issues exist regarding Unity component end-of-life:

- Operating systems upon which Unity applications reside are reaching end of life and will not be supported by the original manufacturers.
- Several 3rd party commercial off-the-shelf applications, declared as part of the qualified system, have reached end of life and will not be supported by the original manufacturers.
- Commercial off-the-shelf hardware components declared as part of the qualified system have reached end of life and will not be supported by the original manufacturers.

2.1.2 Hart System 6.2.1

The Hart System 6.2.1 was originally qualified by NASED in August 2006.

The State of California “Top-to-Bottom” voting system review’s source code analysis pertaining to the Hart 6.2.1 system can be found at:

<http://www.sos.ca.gov/voting-systems/oversight/ttbr/Hart-source-public.pdf>

The review identified four major architectural errors that are present throughout the Hart system:

- **Authentication Failures.** Components of the Hart system routinely assume that any input they receive from an entity speaking the Hart protocol is authorized and will act on it without question.
- **Least Privilege Violations.** In many cases, the Hart protocol allows peer agents to perform actions that are unnecessarily powerful.

- **Lack of Input Validation.** The Hart software frequently fails to check input values before using them internally.
- **Misuse of Cryptography.** Cryptography is not used in places where it should be; where it is used, it is used in non-standard and ineffective ways.

Other issues can be found in the referenced report. Several of these include:

- Operating systems upon which the voting system applications reside are reaching end of life and will not be supported by the original manufacturers.
- Several 3rd party commercial off-the-shelf applications declared as part of the qualified system have reached end of life and will not be supported by the original manufacturers.
- Commercial off-the-shelf hardware components declared as part of the qualified system have reached end of life and will not be supported by the original manufacturers.

2.1.3 Hart System 6.0

Hart System 6.0 was originally qualified by NASED in March 2006.

As System 6.0 was a precursor system to System 6.2.1, with older versions of the same applications, the same architectural, security and end-of-life issues that reside in System 6.2.1 are resident within System 6.0.

2.1.4 Premier GEMS 1.18.24

GEMS 1.18.24 was originally qualified by NASED in June of 2005. A series of modification qualifications being implemented with the last occurring in October of 2006.

The State of California “Top-to-Bottom” voting system review’s source code analysis pertaining to Premier GEMS 1.18.24 can be found at: <http://www.sos.ca.gov/voting-systems/oversight/ttbr/diebold-source-public-jul29.pdf>.

The write-up describes a variety of systemic and architectural issues, including:

- The system includes many large attack surfaces, which is where interfaces are exposed to an attacker. This includes all operations that the attacker can invoke, any data that the attacker can control, protocols that the attacker can participate in, and so forth. The larger the attack surface, the more degrees of freedom the attacker has in crafting attack strategies.
- The system presents high levels of complexity in areas where higher levels of complexity are considered a significant contributor to reduced security.
- The system was determined to contain insufficient controls on code integrity, and there is not a secure method for election officials to verify the integrity of the resident software on a device.
- Validation of inputted data was not confirmed in a consistent manner.

Other issues can be found in the referenced report.

Additionally, the Premier GEMS 1.18.24 system was reported to have crashed during the results upload phase in a past election in Cuyahoga County, Ohio. A subsequent technical review found that this was due to a timing issue/packet collision at the GEMS server. Additional concerns regarding Premier GEMS 1.18.24 include:

- The Premier product line was sold and split between ES&S and Dominion Voting. As such, the continuation of this line of systems may be in question as each manufacturer is only maintaining the current product without declared intentions of furthering the feature set.
- Memory cards for transfer of vote data from voting devices to accumulation and tallying applications are becoming obsolete.
- Operating systems upon which the voting system applications reside are reaching end of life and will not be supported by the original manufacturers.
- Several 3rd party commercial off-the-shelf applications declared as part of the qualified system have reached end of life and will not be supported by the original manufacturers.
- Commercial off-the-shelf hardware components declared as part of the qualified system have reached end of life and will not be supported by the original manufacturers.

2.1.5 Sequoia WinEDS 3.1.074

WinEDS 3.1.074 was NASED qualified in October of 2006.

The State of California “Top-to-Bottom” voting system review’s source code analysis write-up regarding Sequoia WinEDS 3.1.074 can be found at:

<http://www.sos.ca.gov/voting-systems/oversight/ttbr/sequoia-source-public-jul26.pdf>

- This review made the determination that critical election component software safeguard mechanisms were largely ineffective or absent at multiple levels within the voting system, and that the system was too reliant on physical security such that data integrity was in question.
- Additionally, the review found that from a security viewpoint, the cryptography aspects of the system afforded ineffective protection.
- Access control features were called into question in several key components of the voting system as the design enforces access control only in the client. The extensive access control system in WinEDS can be completely circumvented by communicating directly with the database. Further weaknesses in WinEDS’s handling of passwords facilitate the discovery of database passwords, any one of which is sufficient to log in to the database directly and gain control of all its contents.

Other issues can be found in the referenced report.

The Sequoia product line was sold to Dominion Voting. As such, the continuation of this line of systems may be in question as the manufacturer is only maintaining the current product without declared intentions of furthering the feature set. Additional concerns regarding WinEDS 3.1.074 include:

- Operating systems upon which the voting system applications reside are reaching end of life and will not be supported by the original manufacturers.
- Several 3rd party commercial off-the-shelf applications declared as part of the qualified system have reached end of life and will not be supported by the original manufacturers.
- Commercial off-the-shelf hardware components declared as part of the qualified system have reached end of life and will not be supported by the original manufacturers.

2.1.6 Summary of Systems Currently Certified by the State of Colorado

While each system has to date satisfactorily conducted elections in their respective counties, as evidenced by the subsections above, each system has deficiencies that have been uncovered. One major issue with a fielded system that has known issues is that the longer it is in the field, the greater the risk that malicious intent attacks will be formulated against that systems known weakness.

There is also potential impact with each of the systems due to many components either reaching end of life for support from the original manufacturers or are nearing end of life for that support. In many instances, counties are reporting that their equipment remains in good working order, however, with the accelerating obsolescence of the underlying software, the systems will become increasingly ineffective or even unreliable. There is concern that while the obsolete software remains in the field, additional defects and vulnerabilities will continue to be discovered, without the benefit of having the original manufacturer supplying updates to fix and close issues. As was discussed in the Premier review, the more defects and vulnerabilities that are found, the larger the potential attack surface becomes. This creates many opportunities for entities with malicious intent to exploit single vulnerabilities or chain several together for a more in-depth attack.

While manual processes and procedures are able to thwart many exterior attack threats, a determined attack effort is always difficult to defend against. With the potential of an insider attack, manual processes and procedures can often be defeated and a system with a large attack surface will be far easier to exploit than a more updated system.

As the State moves forward in selecting a uniform voting system, SLI strongly encourages the State to choose a system that utilizes current, state-of-the-art software.

2.2 Voting Systems

2.2.1 Voting systems that are certified by the EAC but not yet certified in Colorado

The systems listed below have been certified within the Election Assistance Commission (EAC) certification program. The version of the federal standards to which each system was certified is listed in parentheses.

- Dominion Voting Systems Democracy Suite 4.0 (2005 VVSG)
- Dominion Voting Systems Democracy Suite 4.14 Modification (2005 VVSG)
- Dominion Voting Systems Assure 1.3 Modification (2002 VSS)
- Dominion Voting Systems Assure 1.2 (2002 VSS)
- Election Systems and Software EVS 5.0.0.0 (2005 VVSG)
- Election Systems and Software Unity 3.4.0.0 (2005 VVSG)
- Election Systems and Software Unity 3.2.1.0 (2002 VSS)
- Election Systems and Software Unity 3.2.0.0 Rev. 3 Modification (2005 VVSG)
- MicroVote General Corporation EMS Voting System Ver. 4.0 (2005 VVSG)
- MicroVote General Corporation EMS Voting System Ver. 4.0B Modification (2005 VVSG)
- Unisyn Voting Solutions OpenElect Ver. 1.1 Modification (2005 VVSG)
- Unisyn Voting Solutions OpenElect Ver. 1.0.1 Modification (2005 VVSG)
- Unisyn Voting Solutions OpenElect Ver. 1.0 (2005 VVSG)

Having been certified by the EAC certification program, these systems meet all federal requirements, however, as currently stated in Colorado statute, 2005 certified systems are not recognized as certified by the State of Colorado.

Many of the above mentioned systems employ software that is reaching end of life for support status. In SLI's opinion, these should not be candidates for consideration when choosing the next generation voting system to carry the State forward for the next ten to fifteen years. SLI strongly encourages the State to choose a system that utilizes current, state-of-the-art software.

2.2.2 Systems that currently are not certified to EAC requirements nor State of Colorado requirements

Below is a listing of known systems that would potentially fall under this category of being neither certified by the EAC nor by the State:

2.2.2.1 Traditional Voting Systems

- Hart InterCivic - Verity Voting System
 - DRE w/ VVPAT

- Precinct level optical scanner
 - High speed central count optical scanner
- Precise Voting – VotRite
 - DRE-like touchscreen, with paper trail under glass
- TruVote
 - Dell computer installation
- Avante
 - Precinct Optical scanner
 - DRE w/ VVPAT
- Smartmatic
 - Precinct Optical scanner
 - DRE w/ VVPAT
- Unilect
 - DRE-like touchscreen
- IVS
 - Specializes in telephone voting

The systems in this section would fall under the category of “Traditional” voting systems and would be candidates to meet the current standards of the EAC’s 2005 VVSG. These systems would tend to fall under the timelines outlined below in the section *“Process and timeline for certifying voting systems that are not currently certified by Colorado, the EAC, or any other State”*.

2.2.2.2 Non-Traditional Voting Systems

- Everyone Counts Elect
 - Web based ballot delivery
 - Ballot accumulation and tallying
 - Internet voting capability
- SOE (Scytl)
 - Web based ballot delivery
 - Ballot accumulation and tallying
 - Internet voting capability
- Democracy Live
 - Web based ballot delivery
 - Ballot accumulation and tallying

- Internet voting capability
- Safevote
 - Web based ballot delivery
 - Ballot accumulation and tallying
- Konnech
 - Web based ballot delivery

The systems above would fall under the category of “Non-traditional” systems. As such, they would undergo certification using varied requirements from the federal standards. The EAC has indicated that they are willing to work with these newer types of systems, though this will mean special considerations in how the systems will be expected to meet federal requirements. This is likely to prolong the estimated timelines, as detailed under *“Process and timeline for certifying voting systems that are not currently certified by Colorado, the EAC, or any other State.”*

2.2.3 Ballot on Demand Systems

Ballot on Demand systems are designed to save money and resources while providing timely access to any ballot style for a given election. There are several vendors that provide ballot on demand services:

- Advanced Ballot Solutions – Balotar system for ballot on-demand printing
 - Integrates with voter registration systems
 - Integrated audit capabilities
- Robis – askED-Pollbook with on-demand ballot printing option
 - Integrates with voter registration systems
- Runbeck – Sentio Ballot Printing System
 - Integrates with voter registration systems
 - Integrated audit capabilities

At this time the State has been utilizing the Runbeck Sentio Ballot Printing System. The system seems to have been generally accepted as a positive contributor to the election day process, although some counties have had training and support issues related to insufficient resources available from the vendor. Large scale training seminars are scheduled, which should reduce issues in the near future.

Many counties use the ballot on demand feature in combination with a supply of pre-printed ballots. This has enabled the counties to take advantage of the lower costs of high quantity printing with the pre-printed ballots, while not having to overprint a significant quantity of each ballot style. They are able to print ballots as needed once the pre-printed supply has either run low or run out completely. When ballot on demand is implemented successfully in the counties, the acceptance rate seems to be high.

2.3 Process and timeline for certifying voting systems that are not currently certified by Colorado, the EAC, and/or any other State

2.3.1 Overview of Colorado Certification process

Colorado state law currently mandates that any voting system used in the state must first meet the requirements of the 2002 VSS, or a standard implemented after 2008 (Please see “Federal Standards Discussion” section below). The voting system must also comply with Colorado system requirements.

The process for certifying voting systems that are not currently certified by Colorado, the EAC, and/or any other State has several possible paths based on these criteria:

1. If a system has been certified by the EAC but needs to be certified to Colorado requirements, the system would be subjected to verification of only Colorado-specific requirements.
2. If a system has not been certified by the EAC but has been tested to the federal standards and also needs to be certified to Colorado requirements, the test report for the federal requirement testing would be reviewed for completeness and the system would be subjected to verification of Colorado requirements.
3. If a system has not been certified by the EAC nor tested to the federal standards, but has been tested by another state, the other state's requirements would be analyzed for coverage of the federal standards and then the system would be tested to provide full coverage to the federal standards as well as subjected to verification of Colorado requirements.
4. If a system has not been tested to any standards, it would be subjected to testing against the federal standards as well as to verification of Colorado requirements.

The corresponding timeline for each path has several variables that impact the duration of the certification process. Product quality, the number of software applications and hardware devices supported, as well as the number of technical data package documents submitted drive certification testing complexity. These are significant factors in determining the length of the certification process.

Based on a medium sized voting system including 7-9 software/firmware applications (totaling approximately 650,000 lines of code and comments), 1 type of DRE, 1 type of Precinct level Optical Scanner, 1 type of BMD, and approximately 30 documents in the Technical Data Package, an EAC certification would take, on average, approximately 8-11 months. This estimate is based on schedules posted for the most recent test campaigns on the EAC website. This assumes a robust, production ready system that is delivered to the Voting System Test Lab (VSTL) for certification testing.

With the assumptions listed above taken into consideration, as well as the assumption that the applicable federal standards have been successfully tested, verification of the Colorado specific requirements would take approximately an additional 8 weeks. This is based on the current implementation of Rule 45 within the Colorado code.

Usage of another state's testing of a voting system would impact the timeline to the extent that the federal standards are met. This could reduce the timeline anywhere from 11 months to having no impact.

In summary, the anticipated maximum timeline for a system that has not been tested to any standards or certifications would be approximately 13 months.

The minimum timeline for a system that has been tested fully to the equivalent of the federal standards would be approximately 8 weeks.

2.3.2 Federal Standards Discussion

It is important to note that the 2002 VSS is no longer a recognized standard by the EAC. The EAC currently only certifies to the updated standards contained in the 2005 VVSG. No voting system submitted for certification after December 13th, 2007 has been allowed to be certified to the 2002 VSS standard.

Colorado Title I, "**1-5-601.5. Compliance with federal requirements** states that "All voting systems and voting equipment offered for sale on or after May 28, 2004, shall meet the voting systems standards that were promulgated in 2002 by the federal election commission. At his or her discretion, the secretary of state may require by rule that voting systems and voting equipment satisfy voting systems standards promulgated after January 1, 2008, by the federal election assistance commission as long as such standards meet or exceed those promulgated in 2002 by the federal election commission. Subject to section 1-5-608.2, nothing in this section shall be construed to require any political subdivision to replace a voting system that is in use prior to May 28, 2004."

The following description from the EAC regarding the 2005 Voluntary Voting System Guidelines (VVSG) is an excerpt from the following link:

" www.eac.gov/testing_and_certification/voluntary_voting_system_guidelines.aspx"

"On December 13, 2005, the EAC unanimously adopted the 2005 Voluntary Voting System Guidelines (VVSG), which significantly increase security requirements for voting systems and expand access, including opportunities to vote privately and independently, for individuals with disabilities.

The guidelines update and augment the 2002 Voting System Standards, as required by HAVA, to address advancements in election practices and computer technologies. These guidelines are voluntary. States may decide to adopt them entirely or in part prior to the effective date."

The effective date, as defined in volume 1 of the 2005 VVSG, was 24 months after final adoption in December 2005 by the EAC, thus December of 2007.

Given that new voting systems submitted for federal certification for nearly the last six years have not been tested to 2002 VSS requirements, it is strongly recommended that the State revise requirements to recognize currently accepted federal standards.

HB13 1303, section 48, 1-5-701, states that, “All state laws, rules, standards, and codes governing voting systems and polling LOCATION accessibility shall be maintained to ensure that the state is eligible for federal funds”.

With this requirement in mind, the State should ensure that all applicable state artifacts are written such as not to preclude the 2005 VVSG standards.

2.3.3 Overview of EAC Certification process

The federal standards, both 2002 VSS and 2005 VVSG, contain approximately 1200 requirements. These requirements are broken out under two main sections, Physical Configuration Audit, and Functional Configuration Audit. The following two subsections give more detail to these sections.

2.3.3.1 Physical Configuration Audit (PCA)

Physical Configuration Audits cover the voting system’s hardware, TDP documents, and the voting system’s software/firmware components.

Hardware audits involve review of each hardware component against the declared specification, as well as a series of hardware tests that validate compliance to various electrical, storage and safety requirements.

Documentation audits consist of reviewing specific documents against a corresponding VVSG requirements checklist, and confirming that all VVSG required contents are present in a satisfactory form.

Source Code Review (SCR) audits entail scanning source code files visually as well as with automated tools, comparing them to the client’s designated coding standards and/or the VVSG coding standards, as is pertinent.

The goal of the audits is that all client deliverables attain a 100% Certification compliant status. Where deliverables are not Certification compliant, the Certification staff generates discrepancy items. Iteratively, the current list of discrepancies is sent to the voting manufacturer as a Discrepancy Report, which the voting manufacturer then addresses along with delivery of updated artifacts. This process continues until the requirements are satisfactorily met.

2.3.3.2 Functional Configuration Audit (FCA)

The Functional Configuration Audit (FCA) task entails analysis of the client’s Quality Assurance (QA) and Configuration Management (CM) processes, planning relevant tests as specified in the EAC’s certification requirements, and testing of the system.

Broadly, these tests cover:

- The voting system’s hardware and environmental properties
- All VVSG-mandated functionality (as implemented by the client). Areas covered include: Hardware, Accuracy, Security, Manuals, System and Functional, as well as any other areas needed for analysis.
- Any other client voting system functionality not otherwise addressed by the VVSG

For consideration of EAC certification, a system must be compliant with all requirements within the federal standards. The compliance testing is typically an iterative process where the voting manufacturer makes updates to non-compliant areas of the system until all requirements are satisfactorily met.

3 Replacement of Voting Systems

3.1 Analysis of counties need for replacing voting systems

In terms of conducting elections for 2013, 2014 and 2015 under HB13-1303, the move to mail-in elections and use of vote centers has reduced the quantity of equipment needed to conduct an election. This has increased the spare inventories for many counties.

One issue that is expected to be encountered by all counties, is the issue of end of life for support for the underlying operating systems that the currently certified voting systems employ. "End of Life" is a term used with respect to a product supplied to customers, indicating that the product is in the end of its useful life, and a vendor will no longer be marketing, selling, or sustaining it.

End of life for support for an operating system, or any other type of software/firmware application means that no fixes will be made available, regardless of any functionality, performance or security issues that might arise. There are three operating systems in use by the various systems: Windows 2000, which encountered its end of life for support July of 2010, Windows XP which will encounter its end of life for support April of 2014, and Windows 2003 which will encounter its end of life for support July of 2015.

Over half the counties have communicated that they will need to replace their voting systems within the next five years. All surveyed and interviewed counties are in agreement that the next round of purchases will need to involve the latest proven technology.

Several counties have indicated that they believe their systems will continue to serve their needs for another five to ten years.

A potential issue is that if components within the hardware begin to fail due to age, as opposed to usage, replacement parts may be very difficult or even impossible to obtain. Once a component has reached its planned for end of life, parts will become increasingly difficult to obtain.

Another issue that may prevent longer term usage of voting systems is the end of life of supporting operating systems and software applications. Several of the major operating systems in use within the employed voting systems in the State have already reached their end of life dates, or will encounter them within the next 18 months.

3.2 Types of systems necessary under new election model

The current set of voting systems certified by the State are all similar in capabilities as far as election day implementation is concerned. The systems each provide a type of

ballot marking device, optical scanner, DRE and high speed central count scanner. The next generation of voting system(s) employed within the State will need to provide the same type of device classes, at a minimum.

The range of implementation by device type is quite varied among counties.

For tabulation in the voting center, some counties employ primarily optical scanners, with a few DREs situated for assisting disabled voters. Some counties plan to employ a mix of optical scanners and DREs, some of which will be situated to assist disabled voters. Some counties will rely primarily on DREs, with some situated to assist disabled voters.

For tabulation at central count locations, some counties will utilize central count high speed scanners. Other counties will utilize precinct level optical scanners to tabulate ballots. For many of the counties using precinct optical scanners at central count, the cost of a high speed scanner, especially one that is a proprietary, single use type, can't be justified for the relatively small number of ballots to be processed.

For Ballot on Demand (BOD) usage, counties utilize the State provided BOD devices to varying levels. Some counties will rely heavily on the BOD, while others will use a combination of pre-printed ballots along with the BOD implementation.

The desire of the counties is to obtain systems that exhibit significant sustainability characteristics and will last a minimum of ten to fifteen years and also have the capability to adapt to new innovations. High on the list of innovations is the mode of hardware employed for the purpose of casting ballots and for accumulating cast votes.

Many of the counties surveyed/interviewed indicated the need for hardware that is non-proprietary.

One example of this is central count scanners. In this day of cost cutting measures and prolonging the impact of every dollar, counties would like equipment that can be used for multiple purposes, such as high speed scanners that can be utilized every day for other purposes, not just for an occasional election.

Many counties commented that they prefer a "software based" voting system, where the hardware could be upgraded to the newest implementations without the obsolescence of the system's software.

Many counties can foresee when the general public will employ non-traditional means for casting their ballot. This is even addressed in a recent Election Assistance Commission (EAC) interpretation, posted in March of 2013, *"... The EAC is committed to testing and certifying voting systems incorporating new and innovative solutions emerging in the marketplace. Many of these solutions utilize non-traditional voting architecture centered on election specific software, combined with off-the-shelf laptop computers, tablets, and even smart phones...."*

As the mail-in election model matures within the state and the percentage of ballots cast via mail normalizes, consideration should be given to how the overall cost may be affected by actual usage patterns during elections.

DRE implementations provide the convenience of minimizing the of paper ballots needed, which lowers the cost of pre-printing ballots and number of ballot on demand devices needed.

Optical scan implementations provide the convenience of needing fewer devices to accommodate the number of voters casting ballots in person, as well as providing the voter the tangible assurance of the paper ballot.

Samples of actual usage by the voting public during election cycles will provide information to answer key questions in determining quantities and types of equipment needed for counties in the coming years. These include:

- In the central count location do the higher rates of processing with a proprietary scanner outweigh the cost compared to usage of one or more slower but less costly COTS scanners?
- Will the COTS scanner be able to be utilized for other activities between elections?
- For smaller counties, does the use of a precinct count optical scanner make more sense than a faster but more costly high speed scanner, or will the implementation of a statewide uniform system lower the cost enough to make it affordable for the smaller county?
- Will electronic ballot delivery and possibly even voted returns be more effectively enabled by future "non-traditional (e.g., internet-based) voting solutions?
- How will the State incorporate future technologies with a more conventional system?

There are many potential variations in how the State can go about implementing a new system. With the implementation of the mail-in model, the bulk of the processing of cast ballots will be handled by the high speed central count scanners, which makes the selection criteria of these devices a high priority. The implementation of the vote center, to service the remainder of the voting population that doesn't vote by mail, will reduce the number of devices needed. This gives the counties some added leeway in determining how best to meet the needs of their voting population. With fewer overall devices needed, the counties can better afford to continue to offer a heterogeneous environment of DREs and optical scan solutions.

3.3 Development of a uniform voting system

A significant concern among counties was the ability for one voting system to be able to accommodate the large variances between the counties. One difference between counties includes voter population, which can range from approximately one thousand to well over three hundred thousand. Another difference relates to geography, which varies from relatively close proximity counties to widely dispersed counties and may also present the challenge of dealing with extremely varied terrain and communications issues.

The counties are also looking for a system that will be as sustainable as possible into the future. As all of the current State certified systems are encountering end of life issues with their associated third party COTS software applications, new systems under consideration should employ the latest operating systems and other third party applications, to the greatest extent possible.

Many counties talked about a system that was software based, with some level of hardware independence. With the strides in technologies that have been evidenced in the last few years, counties are concerned that any new system purchases are able to take advantage of advances in hardware technology. They are concerned about making a long term commitment that will leave them with a system that becomes obsolete many years earlier than expected. A software based system should be able to utilize the current methods of ballot deployment and accumulation while offering the capability to be upgraded to newer means as well.

3.4 Timing issues based on elections calendar

There are two election periods planned for 2014 (May/June and November), as well as other local undertakings. Because of this schedule, a rollout of a uniform voting system across all 64 counties, and to the State level, a phased approach is recommended. In order to best propagate a successful implementation, once a system has been selected and has successfully completed the State certification process, it is recommended that the state work with the selected vendor to determine the optimal number of counties for an initial rollout out of the new system. This would enable the vendor to ensure that they have the appropriate resources to assist each county participating. Selection criteria in the initial round of counties should include those most willing to participate, as well as those that have the most technological resources to best implement the new system. The focus of the initial rollout should be to carefully select an environment that has the support and infrastructure required for a successful outcome. A failure of any significant degree would only serve to create a reluctance of the other counties in the implementation of the new system.

Time periods for implementation of a new voting system range from five to ten months depending on the type of system implemented, and to ensure proper training and that all county processes and procedures are incorporated. Given this, for a 2014 deployment, a mid-November 2013 initiation would be needed to potentially be in place for a May/June 2014 election, though a November 2014 election may be a more realistic target, depending on the actual system deployment time.

4 Election Related Technological Costs and Funding Sources

4.1 Estimates of necessary equipment costs to conduct elections per HB13-1303 and Colorado election code

One potential option for keeping the cost of a system down is leasing the system, as opposed to an outright purchase. The benefits of leasing would include not only a lower cost for the system but also the opportunity to periodically upgrade to the newest technology that the vendor has to offer.

Another option for keeping the cost down would be to have the State perform the role of help desk where the State has a dedicated group to assist the counties with issues that are encountered during an election cycle. This would be most plausible in the case of a uniform voting system as the specialists would have only one system with which to be familiar. A secondary avenue with the uniform voting system implementation would be to develop a service agreement with the vendor that covers all the counties for a reduced price overall.

The State could look to minimize the overall cost in conducting elections by creating a partnership with any interested state universities to assist in ballot coding and other pertinent support services. One model that could be further evaluated would be that of Kennesaw State University and the state of Georgia. The Center for Election Systems at Kennesaw State University (KSU) in Kennesaw, Georgia, was founded in 2002 for the purpose of supporting the Elections Division of the Office of the Secretary of State of Georgia, in the statewide deployment of a uniform voting system. The Center maintains an arms-length working relationship with the Secretary of State and the vendor, ensuring both independence and objectivity in its work. The Center works with the Elections Division of the Secretary of State, the Georgia county election superintendents, and the vendor to facilitate successful elections. KSU assists in the areas of training, e-poll book deployment, implementation and maintenance of voting equipment, assisting counties and municipalities in the construction of ballots, as well as call center support.

Costing estimation should take into account the cost of each hardware device, the software of the voting system as well as any third party applications not included with the voting system itself, and support and maintenance costs for each applicable component of the voting system.

Hardware costs, which normally account for the bulk of the initial purchase, include the cost of each precinct count optical scanner and any peripheral devices/components, each DRE and associated ADA supplementary components, as well as central count optical scanners.

The software side of the voting system would include the voting manufacturer's proprietary software as well as potentially operating systems and database applications, which can run into several thousands of dollars.

Support and maintenance costs for a voting system over the long term can rival the cost of the initial purchase. As discussed in other sections of this report, the State is strongly encouraged to look into different options to reduce these costs for a purchased voting system.

Below, SLI has estimated the number of devices to be employed by the counties as part of the mail-in election method in conjunction with vote centers. As evidenced by a Department of State survey conducted in April/May of 2013, this new election methodology has a significant impact on the equipment utilized.

For purposes of this report, SLI categorized counties by size such that:

- Counties with voter populations less than 7,500 were designated "Very Small"; this accounted for 33 counties

- Counties with voter populations from 7,500 to 30,000 were designated “Small”; this accounted for 20 counties
- Counties with voter populations from 30,000 to 100,000 were designated “Medium”; this accounted for 2 counties
- Counties with voter populations from 100,000 to 200,000 were designated “Large”; this accounted for 5 counties
- Counties with voter populations over 200,000 were designated “Very Large”; this accounted for 4 counties

In accordance with HB13-1303,

- Very Small counties will account for 33 election day vote centers,
- Small counties will account for 58 election day vote centers,
- Medium counties will account for 13 election day vote centers,
- Large counties will account for 66 election day vote centers,
- Very Large counties will account for 97 election day vote centers,

This results in a total of 267 election day vote centers.

	Number of Counties	Precinct Count Optical Scanners	DRE w/VVPAT	Central Count Optical Scanner	Election Day Vote Centers (EDVC)	PCOS x EDVC's	DRE x EDVC's	CC x # of Counties
Very Small	33	1	2	1	33	33	66	33
Small	20	1	5	1	58	58	290	20
Medium	2	1	5	2	13	13	65	4
Large	5	1	5	6	66	66	330	30
Very Large	4	2	6	8	97	194	582	32
Total	64	--	--	--	267	364	1333	119

Based on historical data and vendor feedback, different categorized counties are given an averaged set number of voting devices as seen in the “Precinct Count Optical Scanners”, “DRE w/VVPAT” and “Central Count Optical Scanner”.

Multiplying by the number of vote centers required under HB13-1303, the projected number of precinct count optical scanners comes to 364. Adding ten percent for backup devices, the total would increase to 405 devices.

Multiplying by the number of vote centers required under HB13-1303, the projected number of precinct count DREs comes to 1333. Adding ten percent for backup devices, the total would increase to 1467 devices.

Actual costs to support this number and combination of devices is likely to vary greatly by vendor. Pricing variations will be effected by market conditions, the costs of the

product solution, pricing model (lease, vs buy), support costs and other factors. Colorado has contacted vendors through a Request for Information (RFI) and will be able to develop budgets using the equipment quantities estimated above, along with actual quotes as responses to the RFI are received directly from the vendors.

With the implementation of the new vote by mail method, it is still somewhat uncertain as to what the final adoption rate will be among voters. After the new state-wide model has matured and percentages of mail-in versus vote center ballots cast are known, actual equipment needs can be better projected.

4.2 Analysis of funding sources available for purchase of new voting systems

After review of several potential sources of funding of new voting systems, it is clear that funding sources outside of the traditional revenue and budget cycle are currently in short supply. Funding sources from organizations including the Election Assistance Commission, the Federal Voting Assistance Program as well as the Americans with Disabilities Act were examined and no matching or other programs were identified. Funding will therefore have to come from state or county appropriations, or conversion of funds from current annual maintenance costs to new capital or lease budgets.

Funding options that can be considered include extended payment schedules, loans provided by the voting manufacturer, leasing instead of purchasing and combination payment where the cost is absorbed by both the State and the counties.

Extended payment schedules would allow the counties to absorb the cost of the new system over a period of several years, instead of having to find funding immediately.

Voting manufacturers can also provide loans to the State and/or the counties to help alleviate the need to immediately fund the purchase.

Several voting manufacturers also have leasing options where the equipment can be returned after a set number of years, or upgraded.

Separate, but also with regard to the considerations mentioned above, is the consideration of the State and the counties combining to jointly cover the cost of the new system. This may well be on a sliding scale taking into consideration each county's situation and ability to cover the costs.

5 County Comments

SLI conducted a two phase survey involving the counties of Colorado. The survey had a written component as well as a verbal one.

In Phase One, a survey was emailed to all of the counties in Colorado. Out of the sixty four counties, forty-three surveys were filled out and returned, in which a varied population of the counties responded. Responses were received from some of the largest, some medium sized and some of the smallest counties in terms of population, as well as from some of the geographically smallest to some of the largest counties.

Questions 1 & 2 dealt with the county's ability to meet the mandates of HB13-1303. The counties felt that they should have no issues with accommodating all aspects of the house bill.

Question 3 dealt with types of devices each county plans on deploying to the vote centers. A wide variety of implementations are planned. Some counties will rely mostly on optical scanners while other counties will rely heavily on DRE capabilities. For central count capabilities, some counties will use high speed central count scanners, while others will utilize precinct level optical scanners instead of the high speed scanners.

Question 4 asked the counties if they have had any technical difficulties with implementing their voting system. Most counties had no issues, though some have equipment that is aging and beginning to have minor issues. One county has a system that does not support all its needed voting variations. Another county reports that its system does not have all needed reporting capability for a vote center with ballot on demand functionality deployed.

Question 5 asked what features would the counties want to see in a new system. Counties want systems that utilize latest technologies and are user friendly in terms of set-up and administration. They want more control of the ballot creation process, as well as election night reporting. Utilization of commercial off-the-shelf products for things like the central count scanners is of significant interest. Counties also want the ability for the system to adapt to new technologies as they come out. Several of the counties expressed concern that they may buy something now only to find out in a year or two that there are significantly improved technologies available that they won't be able to take advantage of.

Question 6 dealt with providing paper ballots at the vote center. Though some counties are heavily oriented to DREs in the vote centers, even they will provide the ability of voting on paper.

Questions 7, 8 and 9 dealt with paper voting in the vote centers and what combination of pre-printed ballots and ballot on demand the counties will employ. With the State having supplied each county with a ballot on demand system, all counties responding look to implement that functionality to some degree. All counties in the survey indicated a combination approach in their on-hand ballot supply, utilizing pre-printed and ballot on demand printed ballots to varying degrees. Some counties have used BOD and are familiar with it, while others will be implementing it for the first time.

Question 10 asked what concerns the counties might have with the ballot on demand system as well as if there are any additional features that they might want to see. Training and support issues were common topics with the surveyed counties. A lack of user friendliness was also mentioned. Some wanted the ability for more BOD systems to be able to automatically link to SCORE.

Phase two employed a telephone interview with counties that responded to a request for discussion. Twenty-eight counties responded to SLI's request. Again, the response was significant in terms of a varied population of counties from the perspective of population size and geographical considerations. The telephone discussions provided

the opportunity to delve a bit deeper into questions on a more interactive basis than what static written questions allow. This gave insight to better understand not just what some of the differences are between counties, but why, and how population size and geographical differences impact the deployment of a voting system.

Question 1 dealt with DRE election day failure rates that the counties have encountered. DREs have held up well to date with low failure rates and counties have expressed satisfaction with these devices. VVPAT errors were a bit more common but were possibly related to quality of paper used, calibration errors, and election installation problems. With the switch to the vote centers, most counties will have a surplus of equipment.

Question 2 dealt with precinct optical scanner election day failure rates that the counties have encountered. The precinct count optical scanners have held up well to date with low failure rates. With the switch to the voter centers, most counties will have a surplus of equipment.

Question 3 dealt with the number of early and election day vote centers, and whether they would only implement the minimum required by HB13-1303 or implement more. Most counties will have only the minimum number of early and election day vote centers. A few counties will implement one more election day vote center than the minimum required. A few other counties may open additional vote centers depending on public comments.

Question 4 dealt with the number of planned precinct scanners per vote center. Most counties will have either one or zero optical scanners at each vote center. Vote centers with zero optical scanners will take ballots to central count to have them scanned. Many counties will use the precinct optical scanners as their central count scanners. One large county will utilize every available precinct counter at their vote centers.

Question 5 dealt with the planned number of voting booths available for marking paper ballots. Most counties plan on having between two and six booths available at each vote center. One large county will have as many as 20 booths set up at vote centers expected to be busier.

Questions 6 and 7 dealt with the planned number of DREs and ADA units per vote center. Smaller counties expected to deploy about 4 DREs per vote center. Larger counties expected to deploy as many as 20 DREs per vote center. At least 1 DRE will be set up for the use of disabled voters, with a number of counties having enough ADA supplies to outfit all DRE units if needed. This is due to increased availability after the consolidation from precinct polling places to vote centers.

Question 8 dealt with whether the counties are planning on implementing ballot on demand functionality or using pre-printed ballots. Most counties will use both, to varying degrees. The counties with more technical abilities and experience with the BOD systems will rely more heavily on the BOD, whereas counties with less experience and/or less training will have a high percentage of pre-printed ballots on hand. A lack of training and support was a common issue noted by many of the counties.

Question 9 dealt with the use of ballot stubs and whether the counties felt that they are necessary or important. The majority of the counties do not favor using the stubs. Generally, smaller counties did favor and use stubs as they liked having a secondary

audit source. Bigger counties talked about issues that the stubs caused, including issues when printing the ballots and when the stubs get out of sequence.

Question 10 dealt with whether BOD systems should be separated from the voter registration system (SCORE). The vast majority of counties prefer that the systems be linked for ease of use and convenience. There were comments that all BOD systems should be able to connect to SCORE, not just the Runbeck system.

Question 11 dealt with whether the counties had funding available for 2013's technical needs. Most counties report adequate funding for 2013 with the caveat that they are not expecting any repair or upgrade costs this year. A few counties have concern about upgrading software due to obsolete operating systems in the current voting systems.

Question 12 dealt with the question of whether the counties had funding available for 2014. Several counties report having budget requests in for 2014, as is their normal process. Several counties expressed concern that they will not have funding for 2014, or not an adequate amount.

Question 13 dealt with the question of how should a new uniform voting system be funded. The most common response was that if the State mandates a new system, then the State should fund it. Other responses included ideas that some percentage of the cost be covered by the State, and also ideas of spreading the purchase over multiple years, which would give counties time to budget accordingly.

Question 14 dealt with what other types of assistance the State could provide. Many of the counties expressed a need for additional technical training in the use of the BOD system. One common comment was the counties' satisfaction with assistance from the State, describing the State's support staff as knowledgeable and helpful. When a uniform system is put in place, many counties commented that they would like to see the State replace the vendor help desk with State personnel. The counties would also like to see the State be a central source of supplies at presumably better prices than obtained from the vendor directly. A few counties mentioned the prospect of the State having a pool of "loaner" equipment in case a county had an immediate need. There is a significantly wide variation in opinions of the counties as to how much assistance is needed from the State. While several of the more well funded counties, both large and small, expressed that only minimal services were needed from the state, many of the less funded counties indicated the need for as much assistance as possible from the State. Additional training on the current ballot on demand system, partial to full assistance in the purchasing of a new uniform voting system, maintenance of the systems, to assistance in building the ballot styles, were some items listed by those counties.

Question 15 addressed whether the counties had experienced any issues with the State on election day. A few counties mentioned the issue that occurred with SCORE in the 2010 election. The most common response was that the counties had not encountered any problems of any significance with their interaction with the State on election day.

Question 16 asked the counties if they had a backup plan in case the SCORE system experienced a failure. Most counties had a plan in place, whether having printouts of poll books in place or having an electronic copy of the database on laptops. A few

counties did not have a backup plan in place, though this question seemed to prompt them to rethink the issue.

Question 17 asked the counties if they felt that SLI had asked everything that we should be asking, or if they had questions that we should be asking. Potential additional questions included life expectancy of current systems; what are counties replacement schedules; would counties have an interest in cost sharing with other counties; do counties think implementation of a UVS should occur during a general election year.

6 Analysis of State Needs

During the phone interviews conducted with the counties, SLI was informed of election-day issues surrounding SCORE. Many counties mentioned outage issues encountered in 2010. While the outage was for a relatively short time, it occurred at a peak moment, just before closing of the polls when there is a surge in voter activity. Many counties have put contingency plans in place should SCORE fail at any given time. It may be useful for the State to distribute information to the counties, detailing the improvements and added protection put in place to prevent a re-occurrence of the failure.

For the uniform voting system implementation, in order for the system to meet the needs of all counties, with the least amount of inhibition for all counties, a well defined criteria list will need to be developed prior to the selection of a voting system. Recommended items to be included are reporting flexibility, ease of use of each component, maintainability, sustainability, types of voting equipment supported, as well as flexibility of the system to accommodate new technologies as time goes on.

The state should implement a sufficiently staffed technical group that will be able to assist the counties when technical issues arise.

In a further effort to decrease election costs, the State can look to partner with a state university to assist counties with ballot coding and other pertinent support services.

While a few of the counties appear able to fund much of the purchase of a new voting system, many counties would look to the State to provide the monies needed for the new system. As such, the State will need to look for ways to fund the initiative in order to assist the counties as much as possible.

With the implementation of the new vote by mail method, it is still somewhat uncertain as to what the final adoption rate will be among voters. Once percentages of mail-in versus vote center ballots cast are known after the new state-wide model has matured, equipment needs will be better able to be projected. As the percentage of mail-in ballots goes up, the number of central count equipment will increase as well, while the number of needed vote center equipment will decrease.

7 Summary

The currently deployed systems have held up well in most cases, with only a very few counties having any issues with their system's hardware. After the move to the mail-in election model, most counties seem to have a surplus of equipment. When looking at

the longer term outlook, because of end of life issues and increased vulnerabilities due to obsolescing technology, the risks associated with security, reliability and availability will rapidly increase to unacceptable levels with each passing election cycle. With this in mind, now is the time to begin the process of researching the newest systems and determining what new technologies will be deployed in the next few years.

One issue in the quest for acquiring new systems is that the State must change its regulations to accept the VVSG as the current federal standard, as this version will most likely be the applicable standard for the next two to three years. While the version of the standard does not affect the technologies, or their durability that are implemented within a voting system, the need for the State to stay compliant with federal statutes makes this necessary. Otherwise the State will not be able to consider most of the newer, currently EAC certified systems.

As determined in the survey and telephone interviews, the needs and methods of implementation vary significantly from county to county. In order to meet the needs of the counties, a uniform voting system must be flexible and not overly dependent on proprietary hardware.

Once a system is selected, implementation of the uniform voting system should be phased so success can be built upon and the needs of all counties can be accommodated.

Training and support of any technology implemented will be a key to success. Considerations include some kind of state, third-party or vendor-provided help desk to ensure proper implementation and operation.

Most of the counties like the idea of a uniform voting system, seeing the many benefits that a common system would bring. The few concerns stated were around selecting a system that met the needs of all counties, large and small, as well as selecting a system that has the appropriate technology in place to sustain them for the next ten to fifteen years. The system should have the flexibility and scalability to accommodate new hardware innovations that may enter the voting environment, including the usage of tablets and potentially even smartphones.

There is a wide range of opinions offered by county officials regarding the types of services they would like to have available from the State. For instance, many of the more well funded counties expressed the desire to have the freedom to handle the voting systems as autonomously as possible, taking responsibility for everything, while other less funded counties would like the State to handle as much as possible, from purchasing the system to maintaining equipment and software service packs to even handling the production of ballot styles.

Indications from discussions with counties that participated in the telephone interviews are that a uniform voting system will need to consider the needs of each of the counties in order to foster acceptance and adoption.