Uniform Voting System for the State of Colorado

Response to the Request for Information

Dated February 15, 2013

April 1, 2013

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Clear Ballot
VISUAL VERIFICATION

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Company Overview

Mission

The Clear Ballot Group (CBG) was founded in 2009 in Boston, Massachusetts to develop, market and support a new class of tools for election officials. These tools, built on the principles of a modern software architecture and commercially available hardware and software, are designed to help election officials 1) lower the cost of elections, 2) improve the administration of elections, and 3) build trust in the stakeholders of an election – candidates, parties, interest groups, citizens and the media.

Clear Ballot's first product is an automated, independent audit system that is based upon a simple but technically challenging concept:

> **Trust in elections is best achieved when results can be independently verified and *every* computed result and human decision can be quickly reviewed and succinctly displayed for *visual verification*.**

The founders' vision is that it is the role of technology to present the evidence of voters' intent, make it efficient for canvassing boards to adjudicate ambiguous intent, record all decisions – human and software, and deliver the final results in a visually intuitive way that can easily be distributed to the stakeholders of an election as broadly as election law allows.

Founders

The founders of Clear Ballot, Larry Moore and Tim Halvorsen, are seasoned software professionals. They bring strong senior management experience and a proven track record to the creation, building and marketing of highly secure, broadly distributed and supported software products. Larry Moore has been CEO of four companies and was Senior Vice President of Lotus Development and the driving force behind the launch of Lotus Notes. He has founded two companies as well as managed an organization of over 300 professionals. Tim Halvorsen was a principal architect of Lotus Notes and has managed over 500 software engineers. Together, they lead a team of product and business development professionals and senior software engineers who bring a fresh perspective to elections: lower costs, transparency and speed.

For the first 3.5 years, until the major technological hurdles were cleared, the company was financed by the founders. In October 2012, a Series A investment round was made by a single individual. With this funding, the company has been able to recruit a strong management and development team, expand its pilot program and package the audit product for a June 2013 launch.

Company History and Election Experience

To gain election experience, Clear Ballot's founders forged relationships with election officials, initially in Florida and New Hampshire (with Sec. of State William Gardner) and later in Connecticut and Arizona. In June 2009, Leon County Florida Supervisor of Elections Ion Sancho provided the company with access to the 2008 General Election ballots. Over an eight-day period, 149,000 ballots that were scanned into images became the initial dataset for the company's software development efforts. In January 2010, Florida Secretary of State Kurt Browning was introduced to the company and provided introductions to a number of the key Supervisors

of Elections in Florida. Over the next 16 months, the company developed a prototype of the first automated independent auditing system.

Florida Election Verification Project

In August 2011, following the demonstration of a functional prototype, Sec. Browning initiated the Florida Election Verification Project – a year-long set of pilots spanning a complete election cycle. Beginning in October 2011 and ending in December 2012, members of Clear Ballot made four trips from Boston to Florida. Across seven counties and 27 elections, over 1.5 million ballots from all three certified voting systems were scanned into image files and the results tabulated from the images.

Between each visit, Clear Ballot's software rapidly improved as the team's experience with real-world elections grew. For example, on the first trip in 2011, it took several hours to deliver the first results; on the last trip, results were available instantly after the last ballot was processed. The team has learned about the complexity of primary elections and the scale of a General. Clear Ballot's system now handles split-precinct reporting, multi-card ballots, cross-endorsed candidates and ballot rotation.

New York State EAC Grant

In February 2012, the New York State Board of Elections contracted with Clear Ballot to extend its software to support the State's two certified voting systems, the ballot layout unique to NY State and certain election laws dealing with cross-endorsed candidates. After a 10 month development effort, the company conducted five pilot elections across three counties. In one instance, Clear Ballot conducted an independent, automated audit using three people working for two hours. This effort had taken 32 people, working nine hours a day, three days to complete using a hand counting methodology.

Lessons Learned

It is fair to say that, over the course of the pilots, the vision of an audit changed. Going into the pilots, the assumption was that success would be defined as a "faster, easier-to-produce report card." But the Supervisors of Elections told us that a "report card" that doesn't help them with the current election is nearly useless. What they want are better tools that help them deliver independently verified elections and the ability to find and fix problems before they escalate. They also want tools to help them show their stakeholders the steps they take to ensure the integrity of their election. As the software and procedures improved, excitement grew when they realized that they could actually deliver a 100% independently audited election *prior* to certification.

Another lesson came from a very close election in Leon County, Florida, where the margin of victory was 0.18%. Under Florida law, if the margin of victory is less than .25%, the under and over votes must be counted by hand. The county staff estimated that it would take over 1,300 work hours to find the 46,000 ballots with under and over votes out of the 293,000 cards cast (the Leon ballot had 2 cards) and then count the contest by hand. Clear Ballot, once the 293,000 cards were scanned in 1.5 days, took only 10 minutes to show conclusively that the correct winner was chosen. This time savings would be a critical boon to an election staff that has just spent an intense 8 weeks preparing for a major election.

Election Challenges

Ballot control is the largest challenge Supervisors face. Even in the most meticulous of election departments, there have been instances of missing ballots. Enormous manual effort is required with today's methods of physically sorting paper to check totals, perform a recount or conduct an audit. Every time human hands touch the ballots, the paper is placed at risk.

At every pilot site, confidence rose once the election staff understood that the ballot count could be trusted, high-quality images were far more convenient to examine than physical ballots and the audit count matched the voting system's count at tens of thousands of points of comparison.

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RFI Response

The first section of the table below presents Clear Ballot's response for information that pertains to an audit system that operates like a central count tabulator. See Appendix 1 for an overview of the Clear Ballot audit system. (For completeness, we attempted to formulate the financial concerns and issues in the RFI's style after reviewing the posted audio transcripts and documents. The responses to the remaining questions are at Appendix 2.)

	Additional Questions	
CO- RFI Ref #	**Tabulation and Reporting**	
9	Allow the reporting of accepted provisional ballots as an individual category along with other categories the State of Colorado may require, including but not limited to, ballots cast during Early Voting, on Election Day, and by mail.	◎
11	Allow accumulated election results to be audited in a risk limiting audit via a single vote cast record.	◎
15	Provide for the efficient processing of ballots that require resolution of voter intent.	◎
16	Provide for a central count accumulation and reporting of votes cast on paper ballots.	◎
17	Allow the centralized accumulation and reporting of all votes cast and the reporting of such votes by method cast including provisional ballots.	◎
18	Allow the centralized accumulation and reporting of all votes cast and the reporting of such votes by candidate, "yes or no", and contest within each precinct in the election.	◎
24	Provide a solution for security of the entire system including physical security, data integrity measures, contingencies, and backup strategies.	O
CBG Ref #	**Financial & Related (as posed and answered by Clear Ballot)**	
A.	Support for multiple ballot types makes it possible to share expertise between departments that use different precinct-based equipment.	●
B.	A range of central count equipment that utilizes the same software enables small and large counties to develop skills on the same software, reducing the support burden.	●
C.	Commercially available, unmodified hardware and software enables jurisdictions to consolidate their purchasing power.	●
D.	Standardized central count hardware and software can be shared among counties during large recounts – even those with incompatible precinct-based equipment.	●
E.	Networkable scanners allow capital expenditures to be deferred until needed (e.g. 2016)	●
F.	Nationally available 24hr on-site service from the equipment manufacturer significantly lowers the cost structure of the software vendor.	●
G.	Highly visual tabulation software can avoid a recount by showing both parties the likely result of a protracted hand count – in a matter of minutes.	●
H.	Modern user interfaces and competitively-honed industrial hardware design reduce training time from days to minutes; equipment skills can be maintained with daily use.	●
I.	Hardware costs can be further reduced as ballots can be scanned prior to election day; for security, vote counts are not visible until the polls close.	●

Legend

● – a benefit of the product
◎ – a feature of the product
O – a capability of the product but the feature is designed for another purpose and may require additional development to perform as indicated.

Staffing & Training

A key design goal has been to minimize the training time and numbers of permanent and temporary staff needed to test and operate the equipment leading up to and during an election. The management of Clear Ballot is keenly aware that its software will only be used infrequently and therefore there will be little opportunity for an election department's staff to develop "muscle memory". Following the strong recommendation of the participants in the Florida and New York State Election Verification Projects, the company is building a task-based user interface that operates in a web browser. The browser interface affords Clear Ballot's engineering staff the technology platform to create modern, highly intuitive user experiences that remain familiar between uses.

The episodic nature of elections means that systems must be easy to use as staff may not remember how to run every system from election to election. This is especially true in the case of large elections, where election departments are required to increase their staffing levels using temporary workers who have even less experience on the department's systems.

This model received an unexpected test in Florida during the 2012 General pilots. Unbeknownst to Clear Ballot, Mark Anderson, the Bay County Supervisor of Elections, had brought in a crew to operate the equipment. Once the scanners and network equipment were set up, Mr. Anderson announced that Clear Ballot personnel would not be allowed to operate the equipment, nor could they handle ballots. Instead Clear Ballot was told it had to train the crew and be available for troubleshooting. Clear Ballot provided a brief ten minute training session and then allowed the Bay election staff to go to work.

At lunch-time, the Operator Efficiency report was reviewed. One operator stood out from the rest; her throughput was 15% higher than any of the other nine operators. Mr. Anderson decided to have her hold a training session before the afternoon scanning was resumed and she provided five minutes of additional training to the rest of the staff. Following her advice, her colleagues were able to closely match her performance for the rest of the day. After fifteen minutes of training, the entire staff was able to utilize the system at a very high level.

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Scanning Performance

This table shows the sustained speed of one scanner scanning varying ballot sizes for two Fujitsu models.

Scanning Speeds for Varying Ballot Sizes					
Scanner Model	Sustained Speed (Ballots/hour) Ballot Size				Typical Application (assumes audit is performed centrally)
	8 ½" x 11"	8 ½" x 14"	8 ½" x 17"	8 ½" x 18"	
fi-6800	5,500*	4,500	3,500	3,100	Large county More than 100k voters
fi-6670	4,300*	3,500	3,000	2,800	Medium county Between 25k-100k voters
fi-6140z	1,800	1,500	1,400	1,400	Small county Less than 25k voters

*Scanning ballots in a landscape format

Staffing Levels

The following table presents the recommended staffing levels based on the number of scanners being utilized. Scanning performance is additive –five fi-6800 networked scanners can scan 8 ½ x 11" ballots at a sustained rate of 27,500 ballots per hour.

Recommended Staffing Levels for Post-Election Scanning Operations and to Perform a Risk Limiting Audit using a Single Ballot Cast Vote Record					
Number of Scanners	# Scanning Operators (Temp workers)	# Prep Staff' (Temp workers)	# Record Keeping (Permanent staff)	Supervisor (Permanent Staff)	Total Staff
1	1	1	1		3
2	2	2	1		5
3	3	2	1	1	7
4	4	3	1	1	9
5	5	3	2	1	11

Audit Scanning Operational Considerations

With 70%-80% of the ballots arriving early, scanning can be done as mail-in ballots arrive, rather than waiting until the polls to close to scan all ballots. Once the polls close, precinct ballots are centralized and can be scanned in 1-2 days.

The number of scanners required and the number of staff needed can be roughly determined by estimating the maximum number of ballots that will arrive by mail on the heaviest day divided by the number of hours allotted in that day for scanning operations. For example, if 75,000 legal-size ballots (representing the heaviest day) needed to be processed over an eight hour period, the scanning capacity needed would be 9,375 ballots / hour. From the table above, 2 scanners would be required. Staffing would be 4 temporary workers and 1 permanent staff.

Risk Limiting Audit (RLA) Considerations

Clear Ballot's first pilot of the RLA procedure will be conducted in El Paso County, CO on April 3, 2013. The purpose of the pilot is establish a baseline set of measurements of the steps involved in conducting an RLA using a single-ballot CVR. The steps are:

1. Scanning the ballots and establishing procedures for maintaining ballot order.
2. Determining the smallest diluted margin across all contests. Determine the sample size.
3. Correcting the cast vote record (CVR) for unreadable ballots (time permitting).
4. Exporting the CVR and supporting files.
5. Generating random numbers external to Clear Ballot's audit product and associate them with BallotIDs in the CVR file.
6. Identifying and retrieving the inventory boxes containing the ballots to be examined.
7. Using the scanner as a high speed, accurate counter, and count down to the ballot to be examined. Establish a method to confirm that the right ballot has been selected, since this process depends on the ability of the scanner operators to keep the ballots in order.
8. Comparing the votes on the ballot to the cast vote record and recording the results.
9. Determining what procedure to follow to deal with discrepancies (e.g. increase the sample size).

For the critical procedures, a baseline set of metrics will be developed with input from the El Paso staff to permit further refinement and the establishment of best practices. These include:

- Scanning performance – the El Paso ballots for the 2012 General are 8.5" x 18" from the Premier voting system.
- Recommended staffing levels and training times.
- Finding the ballots to examine.
- Methods of recording results and dealing with discrepancies.

Finally, we will moderate a discussion of ideas for simplifying and streamlining the RLA procedures.

A note on "sample size"

The sample size for an RLA is dependent only on the confidence level, likely dictated by statute, and the diluted margin – not the size of the election. To compute diluted margin, the denominator in the normal definition of margin, Total Votes in Contest, is increased by adding under voted and over voted ballots. It is important to understand that the sample size of the contest is not computed for the county but for the jurisdictions over which the contest applies. For example, in Congressional Districts races, the sample size is for all the counties in the CD. For reference, the table below gives approximate sample sizes for a 90% confidence level (i.e. a 10% risk).

Diluted Margin	Sample Size
0.1%	4,600
1%	460
5%	90
10%	45
25%	17

Timeline for 2013 – 2014

This table presents a high-level view of the steps that could be taken to implement a state-wide RLA system capable of efficiently conducting a Risk Limiting Audit in the timeframe prescribed under Colorado Revised Statute 1-7-515 and subsequent rules.

Ref	Date	Activities & Events	Description
A		***Proof of Concept***	***Where***
A-1	Apr 3, 2013	Pilot with Premier	El Paso County
A-2	Apr 4	Public Demonstration	SoS offices
B		***Skills transfer***	***Objectives:***
B-1	Sept-Nov	2012 General Past Election (8 counties)	• Demonstrate ability to support and scale to all election types (muni, primary & general) in 4 small and 4 large counties across all voting systems. • Begin skills transfer to (assumed) State Election Agency support organization.
B-2		Municipal Elections (20+ counties)	• Test support model, design educational, training and audit reporting materials. • Test Clear Ballot's ability to scale to multiple, simultaneous pilots. • Gather & implement additional product requirements.
C		***Planning, Execution & Review***	***Objectives***
C-1	Jan-May 2014	Planning for Primary Election	• Develop educational training curricula. • Finalize a statewide and Congressional District uniform audit reporting format. • Conduct training for all sites selected for the Primary. • Define success metrics for the Primary.
C-2	June	Primary Election	• Locally conduct county-level RLAs in all or selected counties. • Perform 1 selected Congressional District RLA.
C-3	July	Post-Election Review & Analysis	• Produce and submit report analyzing the results of the state-wide RLA. • Compare/contrast actuals vs success metrics.
C-4	July – October	Planning for General Election	• Make final adjustments to support, training & educational materials. • Review support plan / make adjustments. • Hold regionally based training sessions for election department staff.
C-5	November	General Election	• Efficiently perform a Risk Limiting Audit for all local, county, Congressional Districts and State-wide contests.
C-6	Jan-March 2015	Post-Election Review & Analysis	• Produce and submit report analyzing the results of the state-wide RLA. • Compare/contrast actuals vs success metrics.

Support Models

Clear Ballot's management has extensive experience in developing and working with 2-tier support models. In the early 1990s, Clear Ballot's CEO headed the product group in Lotus Development Corp. that began a reseller community that grew to 6,000 resellers and application developers in five years.

The diagrams below depict the current and evolving support models for election jurisdictions. On the left side of the table is the current support model followed by most hardware and software companies. With the proliferation of the Internet, sophisticated support models have emerged that create a vision for the election industry as it seeks to balance security concerns, lengthy and costly certifications and ever-tightening budgets.

<table>
<tr><th>Software & Hardware Industry</th><th>Election Industry
Current Structure</th><th colspan="2">Election Industry
Evolving Support Models</th></tr>
<tr><td>Two-Tier
Classical Support Structure</td><td>One-Tier</td><td>Two-Tier
State Elections Agency as Service Provider</td><td>Two-Tier
State Elections Agency as Service Provider
With Third-Party Support Model</td></tr>
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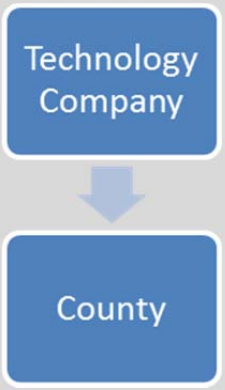
<td> 
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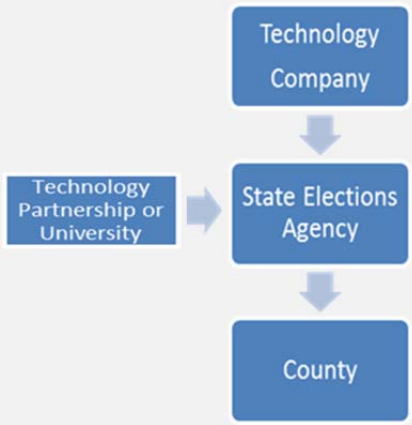
<td> 
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<tr>
<td>Support tiers:
Level 1: Tech companies host on-line knowledge bases; end users help end users with assist from tech company (e.g., posted responses, live chat, screen sharing, hot fixes, etc).

Level 2: Reseller provides first-line support incl. on-site.

Level 3: Technology company provides phone & screen-sharing support.</td>
<td>Comments:
The current model is not suited to the highly episodic nature of elections. Vendors, having to maintain and train an army of "stringers" for Election Day support, have no choice but to charge "peak load" prices. As labor costs rise, the economics of supplying local support to financially stressed counties creates observed pricing anomolies (e.g big counties pay for small ones).</td>
<td colspan="2">Clear Ballot believes that an evolution from the State initially acting as the Service Provider followed by skills transfer to an entity with stronger technical skills is the best support model for this industry.

• Moderated knowledge bases can be established (Level 1),
• Skills can be immediately transferred to the State (Level 2), and
• A Level 3 support organization can be staffed for the 2016 General.

Longer term, involvement with an in-state university has a great deal of appeal.
• Technical skills are more easily transferred, and
• Young people can be brought into election administration

Clear Ballot recommends that the Sec. of State contracts with a technology company for dedicated support from 2013 through the 2016 General Election with a transition plan to bring on a university partner.</td>
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Certification, Examination & Related Topics

An audit system typically does not require certification because it does not produce an official tabulation of votes. Clear Ballot, to perform its audit, independently tabulates the vote to the same level of detail as the primary voting system and then automatically compares the two results at, in some cases, tens of thousands of points of comparison.

The Florida Bureau of Voting Systems Certification (BVSC)

In February 2013, Clear Ballot was invited by the BVSC to take the product through a formal examination. In that examination, information was submitted of the type that would normally be included in a Technical Data Package (TDP) for an EAC-authorized Voting Systems Test Lab (VSTL). This information included such items as Clear Ballot's Election Official's Guide, Operator Checklists, Supported Configuration Document, Change & Version Management Plan and the complete Changelog including system change information from a baseline hash of the system on 9/12/2012 to the date of certification.

The software was also tested for accuracy and the ability to recognize marginal marks on ballots from several voting systems. Absentee ballots, which cause problems for most voting systems, were shown to scan almost without interruption. Fujitsu scanners proved themselves able to handle folded ballots, avoid miss-feeds yet reliably detect them when they occur, and still maintain high throughput rates without damaging ballots. The Bureau's test was further evidence of the superiority that hardware developed in a highly competitive commercial environment has over proprietary hardware.

Finally, there was keen interest in how Clear Ballot could process ballot styles from different manufacturers. We performed a live demonstration by converting 50 ballot-style PDF files into ballot definition files.

New York State Bureau of Elections

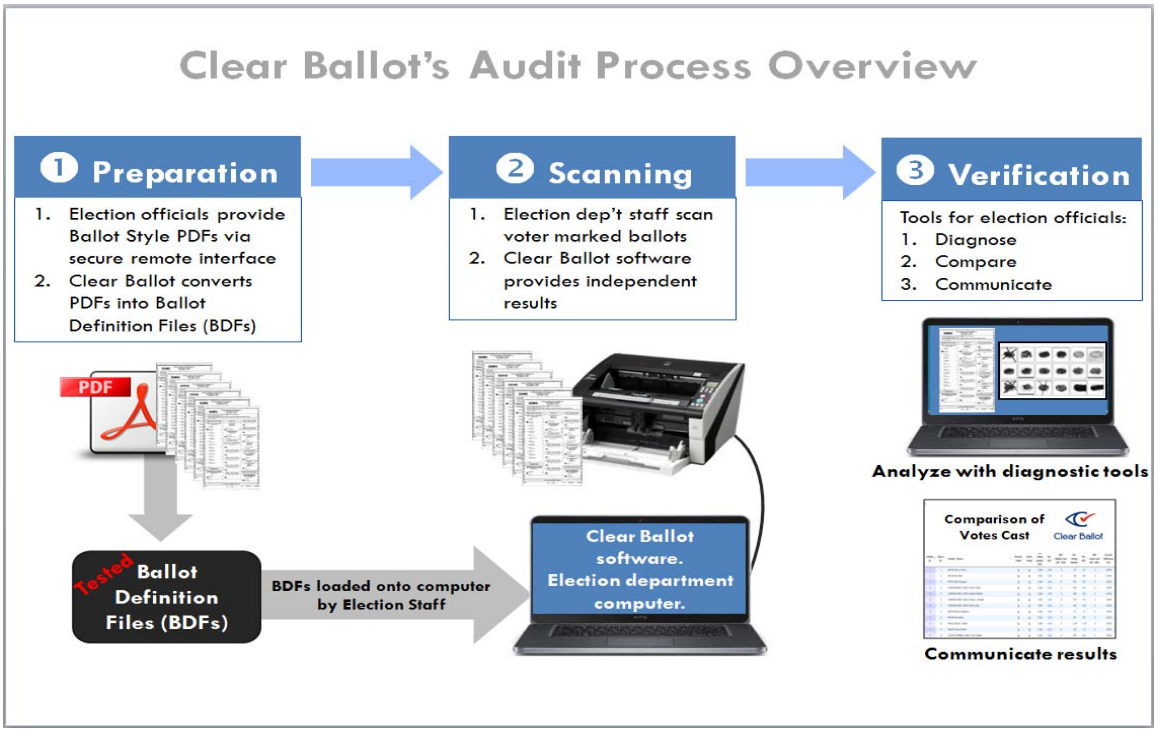
Audits in New York State are performed, as in Colorado, on a tabulator-by-tabulator basis. In New York, however, a manual recount of all the races is conducted on the ballots process by a random sample of 3% of the tabulators used at the Election Districts (precincts). Currently, the tabulators used to process mail-in ballots are based on old, outdated equipment and are not audited.

Clear Ballot, under an EAC grant with the New York State Board of Elections (NYSBoE), has performed five successful pilots on voting systems from ES&S and Dominion. Based on the feedback from the pilots, in March 2013, the Board extended Clear Ballot's contract in an area that is also important for Colorado. Specifically, they asked for a software tool so that Canvassing Boards can use Clear Ballot's vote visualization software to make and fully document changes in the adjudication of all marginally marked ballots and "outside-the-oval" voter intent (New York is a "voter intent" state).

Appendix 1: Clear Ballot Audit Methodology Overview

Clear Ballot's audit method is an automated accounting-based audit rather than a manual or statistical audit. To perform its audit, the system independently tabulates the vote to the same level of detail as the primary voting system and then compares the two results at, in some cases, tens of thousands of points of comparison.

As shown in the diagram below, an audit conducted with Clear Ballot's audit system is a three-step process.



Clear Ballot's technology is packaged as a highly scalable, low-cost, high speed, statistically and visually verifiable system.

- Scalability – the ability to meet the needs and budgets of both small and large counties is achieved by sourcing multiple scanner models. Small counties benefit from the cost-savings of using cheaper, lower-throughput models, while large counties and states can network together multiple high-speed, affordable scanners to achieve significant throughput.
- Low-cost – Cost control is achieved by using competitively-priced commercially available scanning hardware and software. When there are no elections, the equipment can be fully utilized by Clerk/Recorders to digitize voter registration forms.
- Speed – Large-scale network-based configurations are fully capable of tabulating ballots at sustained speeds that eclipse all other vendors who use proprietary hardware.
- Statistical and Visually Verifiable Results – Combining a Risk Limiting Audit method that provides statistical confidence with Clear Ballot's ability to provide visual confirmation of the vote count in every contest sets a new standard in election integrity and transparency.

Appendix 2: Additional Responses

The table below is provided to show a complete response to all of the topics raised in the RFI.

CO- RFI Ref #	Requests for Information	CBG Response
	Precinct DREs	
1	Provide for the design, creation, and testing- of ballots to be voted electronically or on paper, and for the importation of the ballots into an electronic voting unit upon or through which an individual voter may cast his or her ballot on all contests for which the voter is eligible.	o
2	Capture the voter's vote electronically and provide for output to a paper ballot for tabulation.	o
3	Provide a method for the voter to receive and visually verify that the correct ballot is displayed in the electronic voting unit.	na
4	Allow vote capture by electronic means and provide for a voter verifiable paper audit trail.	na
5	Allow vote capture by electronic means and meet accessibility standards, including providing the voter the opportunity to access an audio ballot or other accessible ballot form, and to cast a ballot privately and independently.	na
6	Allow the importation of audio ballot content that may have been created externally.	na
7	Allow the voter to review, change, and confirm choices made while casting votes on the electronic vote capture system.	na
8	Allow the casting of provisional ballots electronically and the segregation of these ballots from other ballots cast until verification of voter eligibility is complete.	na
10	Provide for accumulation, tabulation, and reporting of all votes cast by electronic means.	na
12	Allow printing of a removable paper copy of results at the polling site from each individual electronic voting unit used.	na
19	Allow production of a uniform precinct-level electronic results export.	na
	Ballot Design and Printing	
13	Provide for the design and development of paper ballots by ballot style and precinct, on two-sided ballot pages, and multiple page ballots.	nn
14	Provide for the printing of paper ballots on demand for issue via mail, at polling sites, through County Elections Offices, and Service Centers.	nn
	Internet Voting	
20	Allow secure electronic delivery and return of ballots for voters qualifying under the Uniform and Overseas Citizens Absentee Voting Act and other voters allowed by federal or Colorado law to receive or cast ballots by secure electronic delivery methods.	na

CO- RFI Ref #	Requests for Information	CBG Response
	Vote-by-Mail & Related	
21	Allow automated verification of voter signatures via comparison with voter registration file signatures and the signatures provided on mail ballot return envelopes. These systems must provide a means to calibrate acceptance criteria.	na
22	Provide automated sorting of mail ballot envelopes to various jurisdictional or precinct level divisions.	na
23	Provide, possibly in conjunction with sorting or signature verification, the attachment of a date stamp to the mail ballot envelope.	na
	Other	
25	Allow electronic tracking of voting equipment location.	na
26	Provide for a real time electronic poll-book.	na
27	Systems must be able to provide content and instructions in both English and Spanish with the potential for adding additional languages in the future.	na

Legend

na – not applicable for a central count, paper-based tabulation or audit system
nn – not needed in audit software
● – a benefit of the product
◎ – a feature of the product
O – a capability of the product but the feature is designed for another purpose and may require additional development to perform as indicated.