ClearVote 2.3

ClearVote System Overview

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Clear Ballot Group
2 Oliver Street, Suite 200
Boston, MA 02109
857-250-4961
clearballot.com

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04/06/2023	Minor edits	1.1.5	Douglas McCulloch

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Preface

This section defines the purpose of this document.

About this document

This document describes the following:

- The features of each ClearVote product
- How the ClearVote products interact to provide an end-to-end solution
- Data flows, security, encryption, and other product features

Scope of this document

This document contains the following sections:

- Chapter 1. The ClearVote product family
- Chapter 2. ClearVote: an end-to-end solution
- Chapter 3. ClearDesign: election management system
- Chapter 4. ClearAccess: accessible-voting station
- Chapter 5. ClearCast: Precinct-voting station
- Chapter 6. ClearCount: Central tabulation, consolidation, and reporting system

Intended audience

This document is for election officials and election staff who are responsible for operations and maintenance before, during, and after an election. Clear Ballot personnel also use this document to support election officials and election staff.

Conventions

This section describes conventions used in this document.

References to ClearVote products

A ClearVote® system can comprise the ClearAccess®, ClearCast®, ClearCount®, and ClearDesign® products. Jurisdictions are not required to purchase all products. You can ignore references to any ClearVote products that are not part of your voting system. Also ignore implementation options that are not relevant to your policies and procedures.

BDF and ADF

ClearAccess imports an election definition contained in an accessible definition file (ADF) created by ClearDesign. ClearCount and ClearCast import an election definition contained in a ballot definition file (BDF) created by ClearDesign.

Versions of ClearDesign earlier than 2.0 created unencrypted ADFs and BDFs. ClearDesign 2.0 and later versions produce encrypted ADFs and BDFs. You can distinguish between unencrypted and encrypted ADFs and BDFs by the ending of the filename.

File type	Filename ends in
Unencrypted accessible definition file	adf.zip
Encrypted accessible definition file	adfx.zip
Unencrypted ballot definition file	bdf.zip
Encrypted ballot definition file	bdfx.zip

In this document, the general terms ADF and BDF can refer to both the unencrypted and encrypted versions of these files.

For the specifics of the ADF and BDF file formats, see the following:

- *ClearDesign Accessible Definition File Guide*
- *ClearDesign Ballot Definition File Guide*

Contact us

Clear Ballot Group welcomes your feedback on our documentation. Please send comments to Documentation@ClearBallot.com.

If you have questions about using your product, contact your Clear Ballot representative.

Chapter 1. The ClearVote product family

The ClearVote system consists of four products that are certified as an integrated set of applications (Figure 1-1).

Figure 1-1. The ClearVote product family

Table 1-1 lists ClearVote by election phase.

Table 1-1. ClearVote products by election phase

Election phase	Products
Pre-election	ClearDesign
Vote capture	ClearAccess, ClearCast, ClearCount
Postelection	ClearCast, ClearCount

Chapter 2. ClearVote: an end-to-end solution

Clear Ballot offers a flexible, cost-effective election technology solution that streamlines election management; accelerates adjudication and tabulation; and ensures timely, accurate, transparent reporting. Since 2009, Clear Ballot has pursued the answer to two questions:

- How can we apply modern technology to improve election administration in the United States?
- Can we harness technology to build trust in the results, especially in the closest of elections?

With these questions in mind, we built a team of technology experts and seasoned election industry professionals and put them to work to build a solution. The result is the ClearVote suite of products.

2.1 Purpose of each ClearVote product

The ClearVote system consists of four individual products. Table 2-1 lists the purpose of each ClearVote product.

Table 2-1. Purpose of each ClearVote product

Product	Purpose
ClearDesign	Election management system (EMS)
ClearAccess	In-person accessible voting station
ClearCast	In-person precinct-scan voting station
ClearCount	Central scan and tabulation, results consolidation and reporting system

2.2 Relationships between ClearVote products

Figure 2-1 shows the relationships between the independent products. The ClearVote products exchange data in fully documented, plain text comma-separated values (CSV) files and, in the case of ClearCast, ballot images. These files are digitally signed and encrypted for protection against tampering.

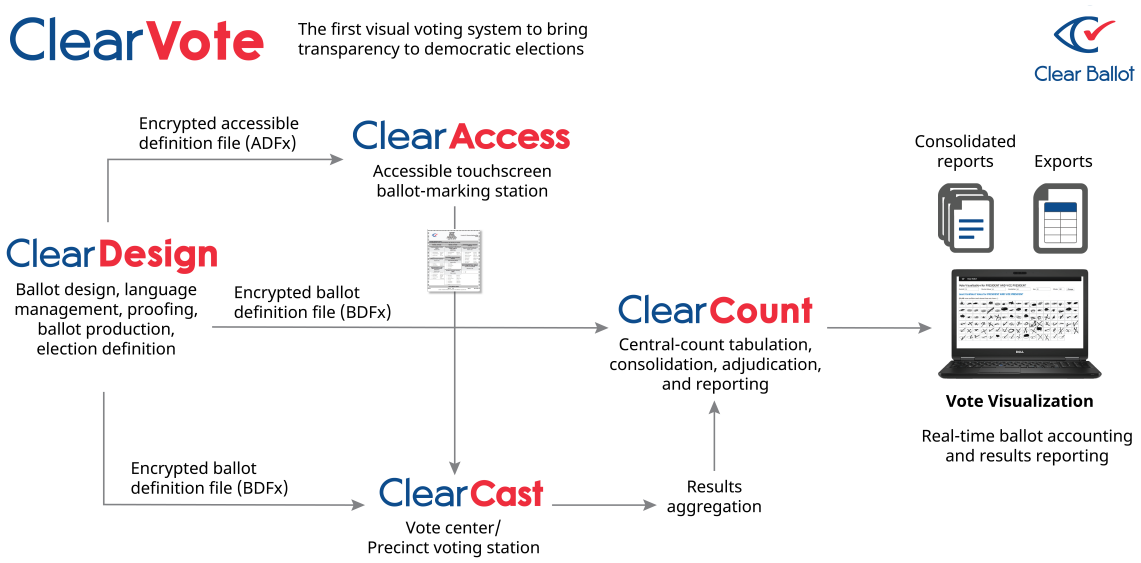


Figure 2-1. Relationships between ClearVote products

2.3 System limits

Table 2-2 summarizes the testing of ClearVote system limits by Clear Ballot.

Table 2-2. ClearVote system limits

Characteristic	Tested Limit	Characteristic	Tested Limit
Election parameters			
Precincts per election	3200	Card styles per election	3200
Splits per election	3200	Contests per ballot style	60
District categories per election	100	Card styles per precinct	50
Districts per single category	3200	Parties per election	50
Districts per election	3200	Counter groups per election	7
Contests per election	3200	"Vote for" per contest	50
Choices per election	3200	Languages per election	15
Choices per contest	300	Cards per ballot (per language)	5
Vote positions per side	420	Write-ins per contest	50

Table 2-2. ClearVote system limits (continued)

Characteristic	Tested Limit	Characteristic	Tested Limit
Reporting name parameters*			
Election name (characters)	60	Contest name (characters)	60
Jurisdiction name (characters)	60	Candidate name (characters)	60
Precinct name (characters)	60	Party name (characters)	60
Vote center name (characters)	60	Write-in length (characters)	60
System parameters			
Central-count scanners per network	10	Cards per central-count device	4,000,000
Cards per precinct-voting device	10,000		

*These limits are for reports only.

2.4 Safety, reliability, and maintainability

The computers, scanners, and printers used with ClearAccess, ClearCount, and ClearDesign are commercial, off-the-shelf (COTS) hardware components. Developed for a broad market, these products are robust, reliable, and well-supported.

A Nationally Recognized Testing Laboratory (NRTL) has tested all COTS hardware used for ClearVote products. All COTS hardware is marked with a UL or other safety mark.

The ClearCast precinct-count optical scanner is a custom-built solution that is manufactured to specification for ClearVote and tested to VVSG standards for safety and reliability.

Chapter 3. ClearDesign: election management system

Jurisdictions use the ClearDesign election management system (EMS) to do the following:

- Create and import jurisdiction data
- Lay out, proof, and produce both paper and accessible ballots in supported languages
- Generate PDFs for ballot-printing companies and on-demand printers
- Generate files that program other ClearVote products

3.1 ClearDesign data flows

Figure 3-1 shows operational environment of ClearDesign in the pre-election phase.

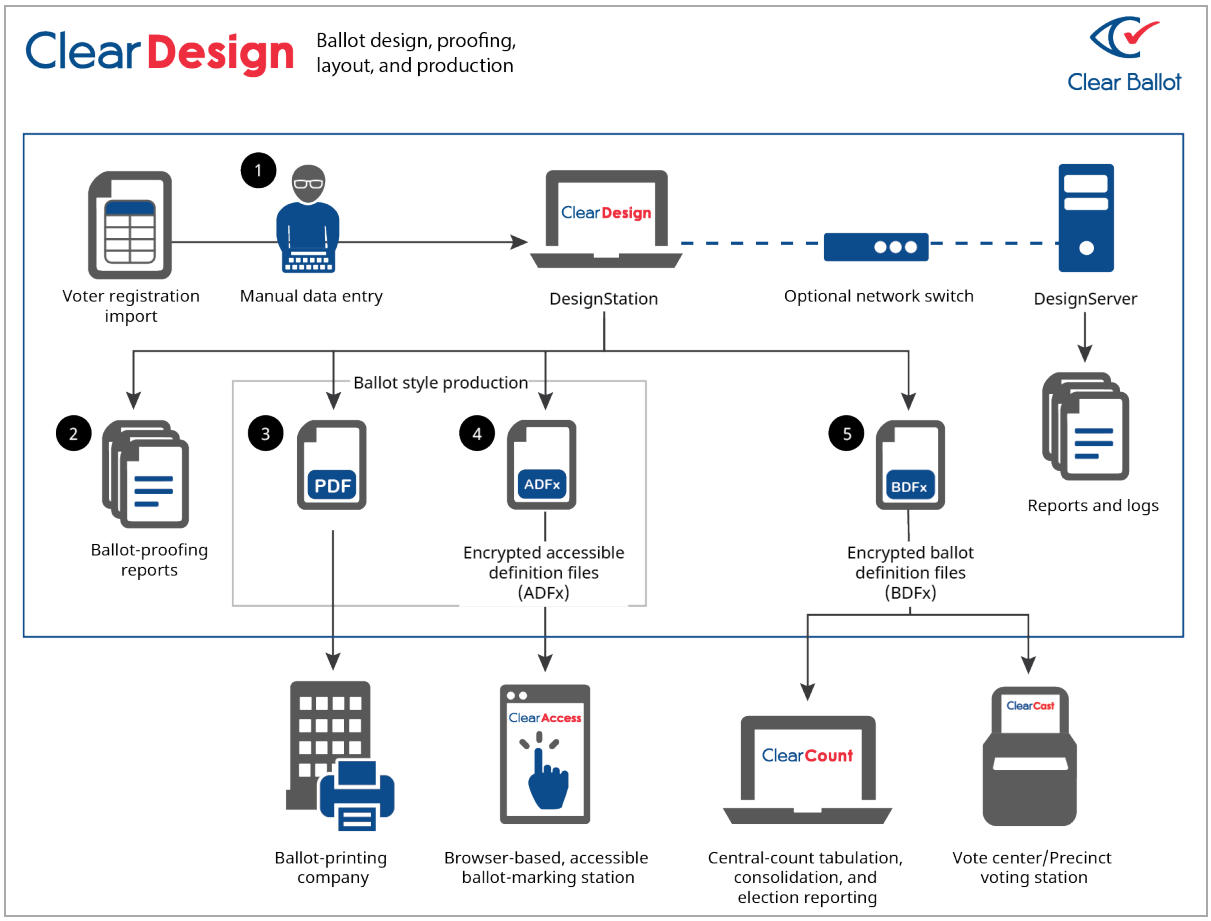


Figure 3-1. Overview of the ClearDesign operational environment

The following list explains the numbers shown in Figure 3-1.

1. A jurisdiction can enter election definition data manually or import it.

2. Ballot proofing is a critical step in creating an election. A library of reports is available for the ballot designer to check the ballots. For example, reports allow a designer to check that candidate names appear as intended, that precincts are correctly assigned to districts, and that contests appear on the correct ballot style.

3. When the ballot designer has finished proofing, ballot style production is completed in a single step. Two forms of ballots are produced simultaneously:

   - The PDF files that are sent to the ballot printing company
   - HTML Anywhere Ballot files that can be loaded onto a device capable of running a modern browser

   When loaded into a browser, the Anywhere Ballot enables in-person, accessible ballot marking. (For more background, see http://civicdesign.org/projects/anywhere-ballot/)

4. The Anywhere Ballot is a single HTML file that contains all the data that a modern browser needs to display a single ballot style. This ballot style allows voters (disabled or not) to select and verify their choices, mark one or more ballot cards, and print them on a low-cost laser printer.

   In operation, all ballot styles for an election are packaged as a single zipped file that can be copied to an encrypted USB drive for installation on the ClearAccess ballot-marking station. When the device is loaded, it can be used directly in a vote center or configured to allow only certain ballot styles to be displayed at a particular polling location.

5. The ClearDesign EMS produces a zipped file that encapsulates all the files needed to program an election in the ClearCast and the ClearCount systems.

   The ClearDesign EMS can lay out ballots of different lengths for the same election. With this feature, 18-inch ballots can be mailed to voters, and 11-inch ballots can be printed on demand at a polling place or voting center with a low-cost laser printer. For 11-inch ballots, two ballot cards may be needed to display all the contests that appear on a single 18-inch ballot. The benefit is that all ballots can be tabulated in the same way, and a low-cost laser printer can be used instead of an expensive printer that is required to print an 18-inch, two-sided ballot.

3.2 Ballot lengths

With the ClearDesign EMS, a jurisdiction can create ballots in many lengths between 8.5" by 5" and 8.5" by 22" in the same election. The number of possible vote positions per side depends upon the length of the ballot. Table 3-1 shows the values for common card lengths.

Table 3-1. Ballot lengths and vote positions

Length (inches)	Vote positions
5	60
11	180
14	240
17	300
19	360
22	420

3.3 Parameters for accurate vote casting

The ClearDesign EMS allows the user to define the various parameters required for accurate vote casting and records, such as:

- The number to vote for in a contest
- The party a contest is associated with
- The district a contest runs in
- Contest rotation
- Special contests, such as straight-party voting

3.4 Validation and import formats

The ClearDesign EMS validates all data entered by the user to ensure it conforms to the system requirements and is consistent. It also supports a variety of import formats that allow election definitions to be directly imported from other applications, such as voter registration systems. These data imports are validated using the same logic as manually entered data to ensure data accuracy and integrity.

The ClearDesign EMS provides over 90 reports for validating and proofing the election definition to ensure that the election is defined correctly.

3.5 Hardware components of ClearDesign

Figure 3-2 shows the configuration of the physical hardware components of ClearDesign.

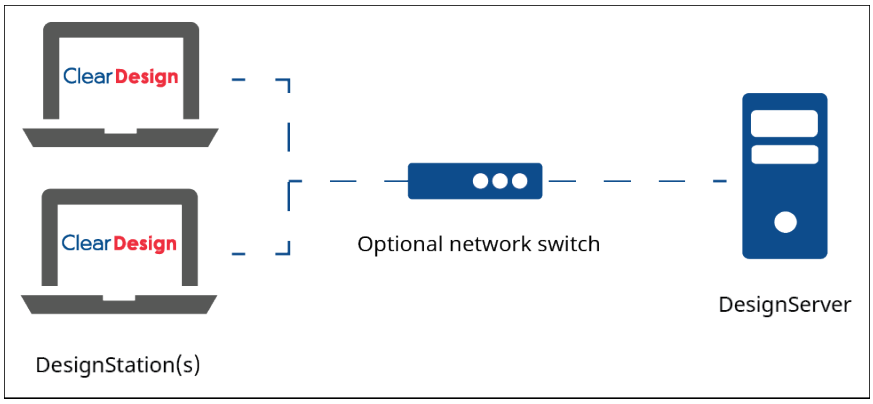


Figure 3-2. Hardware configuration of ClearDesign

Table 3-2 describes each hardware component of the ClearDesign EMS. All components are commercial off-the-shelf (COTS) hardware and are connected over a closed, wired Ethernet.

Table 3-2. ClearDesign hardware components

Item	Description
DesignServer	A computer running the ClearDesign software and hosting the election database and the web server that serves election reports. The DesignServer uses the Linux operating system (a configured version of which is installed with the ClearDesign software). The DesignServer is an appliance.
DesignStations	One or more computers for creating, formatting, and maintaining ballots. The DesignStations run the Windows 10 operating system. Users access the ClearDesign from a DesignStation. Users must have the appropriate permissions to perform specified functions.
Network switch (optional)	Connects multiple DesignStations to the DesignServer over a closed, wired Ethernet. The network switch is necessary only when your configuration has multiple DesignStations communicating with a Design Server. If your configuration has one DesignStation and a DesignServer, you can use an Ethernet cable to connect the DesignStation directly to the DesignServer.

All connections between devices in the ClearDesign system are closed and wired. ClearDesign does not use wireless connectivity. Jurisdictions must disable wireless capabilities on any hardware that is used with ClearDesign.

Chapter 4. ClearAccess: accessible-voting station

ClearAccess is an in-person ballot-marking system designed to ensure access for all voters. ClearAccess runs on commercial off-the-shelf (COTS) computers. The ClearAccess software captures the choices of voters and prints machine-readable ballots.

4.1 How voters interact with ClearAccess

The ClearAccess system runs on a COTS touchscreen computer. ClearAccess enables voters to do the following:

- Indicate ballot choices privately and independently on a touchscreen
- Review the ballot choices and correct them as necessary
- Print a machine-marked ballot
- Cast the ballot by inserting it into the ClearCast optical scanner or into a ballot receptacle.

The ClearAccess software logs all transactions without compromising voter privacy and does not store any results data. The only output of ClearAccess is a marked paper ballot.

4.2 Hardware components of ClearAccess

Figure 4-1 shows the hardware components of a ClearAccess accessible voting system. Table 4-1 on page 17 describes each of the numbered components shown in Figure 4-1.

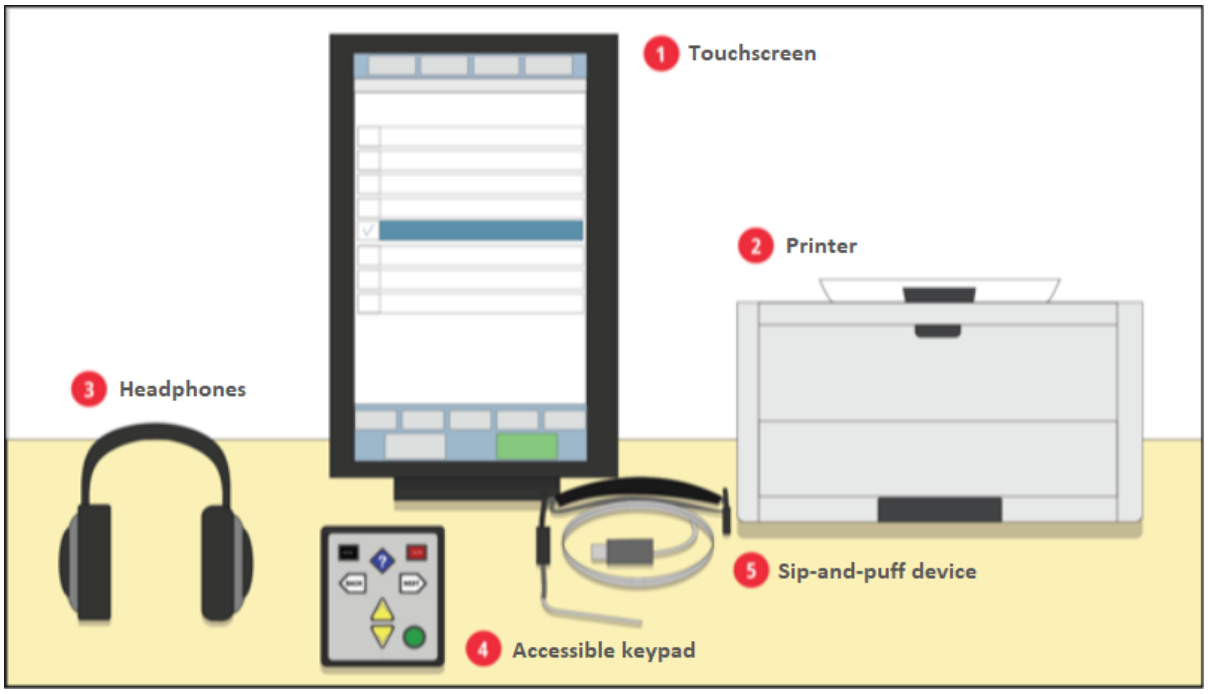


Figure 4-1. Hardware components of a ClearAccess system

Table 4-1. Description of ClearAccess hardware components

Item	Description
1. Touchscreen	The touchscreen provides a visual presentation of the ballot content with options to adjust text size or contrast. Voters can make ballot selections on the touchscreen or can use an assistive device, such as the sip-and-puff device or accessible keypad.
2. Printer	Voters end the ClearAccess voting process by printing a machine-marked, scannable paper ballot.
3. Sip-and-puff device	The sip-and-puff device enables voters to make ballot selections using their mouths instead of touching the screen or using the accessible keypad.
4. Accessible keypad	The accessible keypad enables voters to make ballot selections with a tactile device.
5. Headphones	The headphones provide an audio version of the ballot content.

An uninterruptible power supply (UPS) provides backup power for the ClearAccess system if a power outage occurs. Optionally, jurisdictions can attach a barcode scanner (not shown in Figure 4-1) that enables a poll worker to scan a QR code to select the applicable ballot style for a voter on the ClearAccess system.

Chapter 5. ClearCast: Precinct-voting station

ClearCast is a precinct-count, optical-scanning solution designed for in-person early voting and Election Day voting. ClearCast can also process the paper ballots printed by the ClearAccess accessible ballot-marking system.

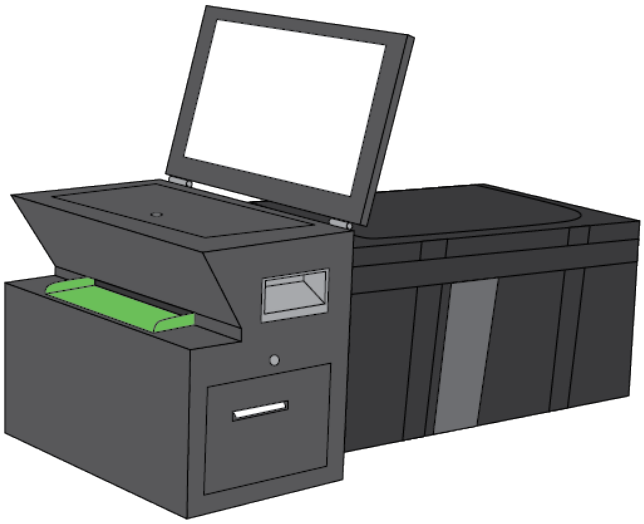


Figure 5-1. A ClearCast voting station

The ClearCast system maintains three copies of election data: one on its internal solid-state storage drive, and two on removable USB drives.

The lightweight station sits on a tabletop or collapsible ballot box. With its small footprint, ClearCast can be transported by passenger car or truck.

The ClearCast ballot bag is collapsible and produced from ripstop canvas. Translucent strips on two sides of the bag allow election officials to see that the bag is filling and anticipate the need to change or empty it. The ballot box is available as a sturdy case or as a space-saving collapsible case.

When polls close, the ClearCast voting station produces a results tape either by precinct or as a summary report of all results. An additional tape showing the images from marked write-in contests is also available. Ballots scanned on the ClearCast system are aggregated to the ClearCount central-count system via one of the redundant USB drives.

Chapter 6. ClearCount: Central tabulation, consolidation, and reporting system

The ClearCount tabulation system captures voter intent and retains ballot provenance to improve election reporting and administration. It handles four important functions:

- Central-count tabulation
- Consolidating results imported from ClearCast precinct-voting stations
- Generating operational reports and contest reports
- Logging the activities and data required for independent audits

6.1 Hardware components of ClearCount

The ClearCount system contains the physical components listed in Table 6-1. All these components are unmodified COTS hardware and are connected over a closed, wired Ethernet.

Table 6-1. ClearCount hardware components

Component	Description
CountServer	A computer running the ClearCount software and hosting the election database and the web server that serves the election reports. The CountServer computer runs the Ubuntu Linux operating system. A configured version of Ubuntu Linux is installed with the ClearCount software.
ScanStations	One or more Microsoft Windows computers linked over a closed, wired Ethernet connection to the CountServer computer through the network switch. Each ScanStation computer is paired to an individual scanner. The computer and scanner pairs are used to scan and adjudicate ballots.
Scanners	Each scanner is connected to a single ScanStation computer with a USB cable.
CountStations	One or more Microsoft Windows computers installed with browser software, linked by a wired Ethernet connection to the CountServer computer by the network switch. Election officials use this computer to create election reports. The election administrator also uses this computer to monitor the system and manage databases and users.
Network switch	Connects the ScanStation and CountStation computers to the CountServer computer over a wired, closed Ethernet.
Uninterruptible power supply (UPS)	Used to ensure that the CountServer computer or other desktop computer is available if a power outage occurs.

Table 6-1. ClearCount hardware components (continued)

Component	Description
External hard drive	Used to back up and restore elections. The external hard drive connects to the CountServer computer. Clear Ballot recommends an encrypted external hard drive. See the *ClearVote Approved Parts List* for approved devices.

The minimum hardware configuration for ClearCount contains:

- One CountServer
- One ScanStation with an attached scanner
- One CountStation

All these components are connected by Ethernet cables to a single network switch.

It is possible to expand a ClearVote configuration to include multiple ScanStations and CountStations with a single CountServer computer.

All connections between devices in the ClearCount system are closed and wired. The ClearCount system does not use wireless connectivity or connect to any other network. Wireless capabilities on any hardware used with the ClearCount system must be disabled.

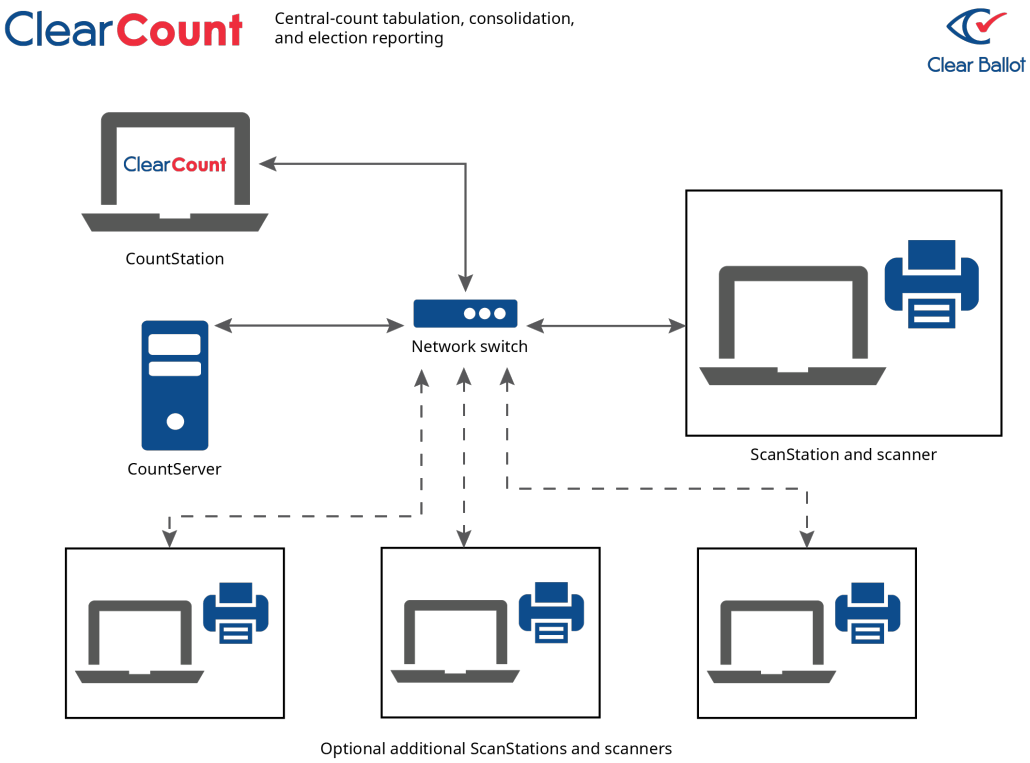


Figure 6-1. ClearCount hardware configuration

6.2 Ballot inventory and control

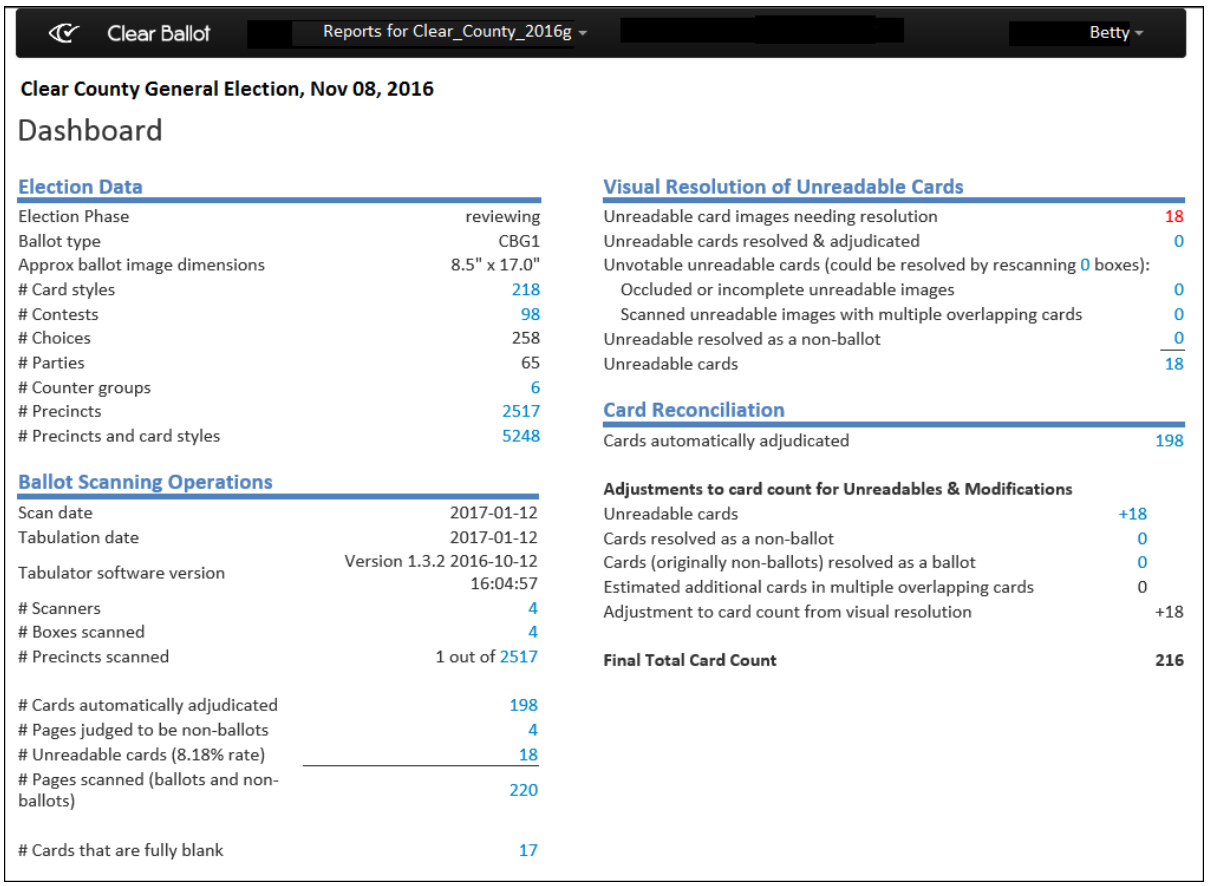
The ClearCount technology allows for ballot control. Ballot batches are identified by a target card, which contains a barcode and is the first card scanned in a batch. By combining the value of the barcode with a sequence number assigned by the scanning software, each ballot card is assigned a unique identifier when it is scanned.

This card ID eliminates the need for physical sorting and tracking of ballots for inventory, reporting, and recounts, but it is not possible to tie this card ID back to a voter. The Card Inventory report summarizes every batch scanned in the election. Officials can view the image of every card in every batch in the order it appears in the physical box.

With the ClearCount central-count system, election-specific data, including card image files and log entries, can be backed up and archived, and restored if needed.

6.3 The Dashboard

The Dashboard (Figure 6-2) is the ClearCount information center. This summary of election operations allows officials to monitor the progress of tabulation, such as the number of precincts scanned and the number of ballots that were automatically tabulated.



Clear Ballot | Reports for Clear_County_2016g | [redacted] | Betty

Clear County General Election, Nov 08, 2016

Dashboard

Election Data

Election Phase	reviewing
Ballot type	CBG1
Approx ballot image dimensions	8.5" x 17.0"
# Card styles	218
# Contests	98
# Choices	258
# Parties	65
# Counter groups	6
# Precincts	2517
# Precincts and card styles	5248

Ballot Scanning Operations

Scan date	2017-01-12
Tabulation date	2017-01-12
Tabulator software version	Version 1.3.2 2016-10-12 16:04:57
# Scanners	4
# Boxes scanned	4
# Precincts scanned	1 out of 2517
# Cards automatically adjudicated	198
# Pages judged to be non-ballots	4
# Unreadable cards (8.18% rate)	18
# Pages scanned (ballots and non-ballots)	220
# Cards that are fully blank	17

Visual Resolution of Unreadable Cards

Unreadable card images needing resolution	18
Unreadable cards resolved & adjudicated	0
Unvotable unreadable cards (could be resolved by rescanning 0 boxes):	
Occluded or incomplete unreadable images	0
Scanned unreadable images with multiple overlapping cards	0
Unreadable resolved as a non-ballot	0
Unreadable cards	18

Card Reconciliation

Cards automatically adjudicated	198

Adjustments to card count for Unreadables & Modifications

Unreadable cards	+18
Cards resolved as a non-ballot	0
Cards (originally non-ballots) resolved as a ballot	0
Estimated additional cards in multiple overlapping cards	0
Adjustment to card count from visual resolution	+18
Final Total Card Count	**216**

Figure 6-2. The ClearCount Dashboard

From the Dashboard, election officials can navigate to other pages of the system. Officials can monitor operations in detail, such as the performance of individual ScanStation computers. They can also access and adjudicate unreadable cards. All election and contest data is updated as each ballot card is scanned. When tabulation is complete, election officials generate the reports required to complete the canvass and certify the election.

6.4 Vote Visualization

The ClearCount voting system includes Clear Ballot's Vote Visualization technology. This technology provides images of scanned ballots to allow click-through examination of every vote on every card. The ClearCount (and ClearCast) system uses white-light, grayscale scanning to make the highest quality card images. Figure 6-3 shows voted ovals for a contest. Each oval links to a high-resolution card image.

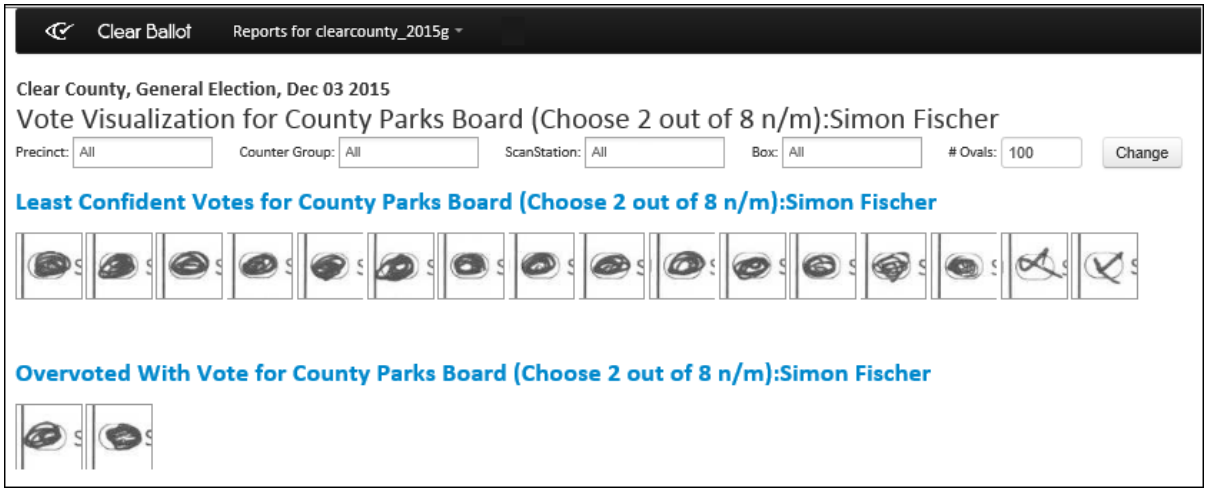


Figure 6-3. ClearCount Vote Visualization

6.5 Write-in Assignments tool

The ClearCount system captures write-in images for all contests that have write-in choice zones associated with them in the BDF of an election.

Election officials can use the Write-in Assignments tool to assign candidate names to write-in images. Those assigned write-in choices can then appear in key ClearCount election results reports, such as the Statement of Votes Cast reports. The assigned write-in choices can also be exported as a CSV file.

Figure 6-4 shows an example of the Write-in Assignments page.

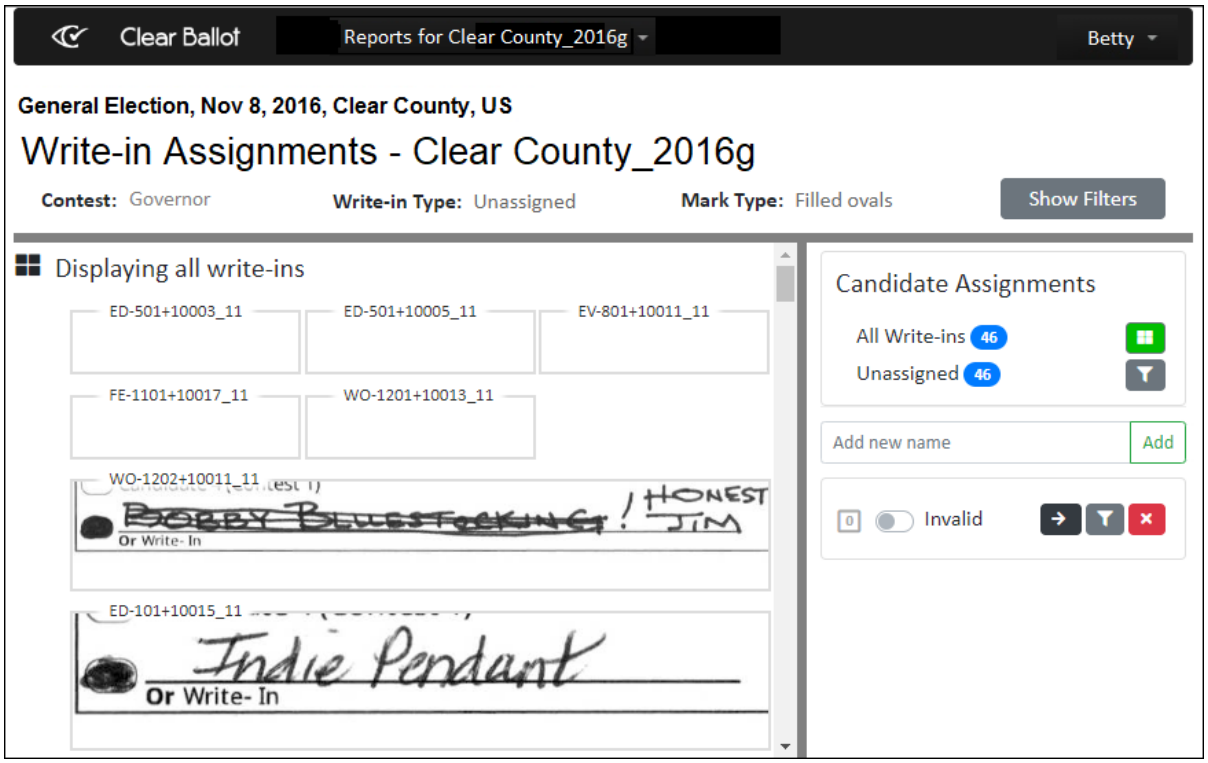


Figure 6-4. The Write-in Assignments tool