ClearCount 1.0
System Overview

Abstract: This document provides information about the functional and physical components of the ClearCount system, including how components are structured and interfaced. It also presents system performance characteristics.

ClearCount System Overview

ClearCount Part Number: 100025-10001

Clear Ballot Group
7 Water Street, Suite 700
Boston, MA 02109
(857) 250-4957
http://www.clearballot.com

Document history

Date	Description	Version	Authors
06/2014	Initial submission to New York.	1.0	Brian Meyers Christine Sigman
03/02/2015	Ongoing clarifications and improvements.	1.1	Brian Meyers Iris Friedman
03/27/2015	Ongoing clarifications and improvements.	1.2	Brian Meyers Iris Friedman
04/03/2015	Ongoing clarifications and improvements.	1.3	Brian Meyers Iris Friedman
07/30/2015	Changed product name to ClearCount to align with functionality.	1.6	Ed Smith Iris Friedman
08/10/2015	Added constraints on ballot stock.	1.7	Brian Meyers Iris Friedman

Table of contents

Chapter 1. Abstract

This section defines the purpose of this document. It contains the following sections:

- About this document
- Scope of this document
- Intended audience

1.1 About this document

This document provides information about the functional and physical components of the ClearCount system, how the components are structured, and the interfaces between them. It also reviews system performance characteristics. It corresponds to the VVSG 2005, Volume 2, Section 2.2 requirement for the Technical Data Package (TDP).

1.2 Scope of this document

This section provides summary information about the following aspects of the ClearCount system:

- High-level system description
- Functional components and subsystems
- Operational environment of the system
- System performance
- Quality attributes and provisions for dependable performance
- Design constraints and applicable standards

1.3 Intended audience

This document is intended for state election officials and their delegated Voting Systems Test Laboratory, as part of the TDP required to certify the ClearCount central-count, optical-scan voting system for use in their state.

Chapter 2. System description

ClearCount is a central count paper-based optical scan system created by the Clear Ballot Group (generally referred to as Clear Ballot).

The ClearCount software runs on unmodified COTS laptop computers running the Windows operating system and supports specific models of Fujitsu scanners.

The ClearCount system is not a precinct count system and is not intended for direct voter interaction.

The election's ballot style PDFs are provided by ClearDesign. Ballot styles are used to create ballot definition files (BDFs). BDFs are used to tabulate ballot-scanning results in its election database. The ClearCount system then produces a suite of election reports that election officials can use to track and analyze results. ClearCount results may also be printed or exported in a variety of formats, including CSV files.

The ClearCount central-count system consists of the following physical components (all of which consist of unmodified COTS hardware and are connected via closed, wired Ethernet connections):

- **ScanServer:** A laptop or desktop computer running the ClearCount software and hosting its election database and the web server that serves its election reports. The ScanServer uses the Linux operating system (a configured version of which is installed with the ClearCount software).
- **ScanStation(s):** One or more laptop/scanner pairs used to scan and tabulate ballots. The ScanStation™ computers use the Windows operating system.
- **Router:** Used to connect the ScanStations to the ScanServer using a wired, closed Ethernet. (Optionally, a switch may be added for larger elections requiring more ScanStations.)
- **Election Administration Station(s):** One or more Windows laptop computers installed with browser software, linked by a wired Ethernet connection to the ScanServer using the router. This laptop is used by election officials to monitor and interact with ClearCount's election reports. This same laptop is used by the system administrator to monitor the system and manage databases and users.

The Tabulator software is accessible from the Election Administration Station. The BDFs are only available on the Election Administration Station. While voting is ongoing, NYS administrative rules prohibit the viewing of reports containing election results.

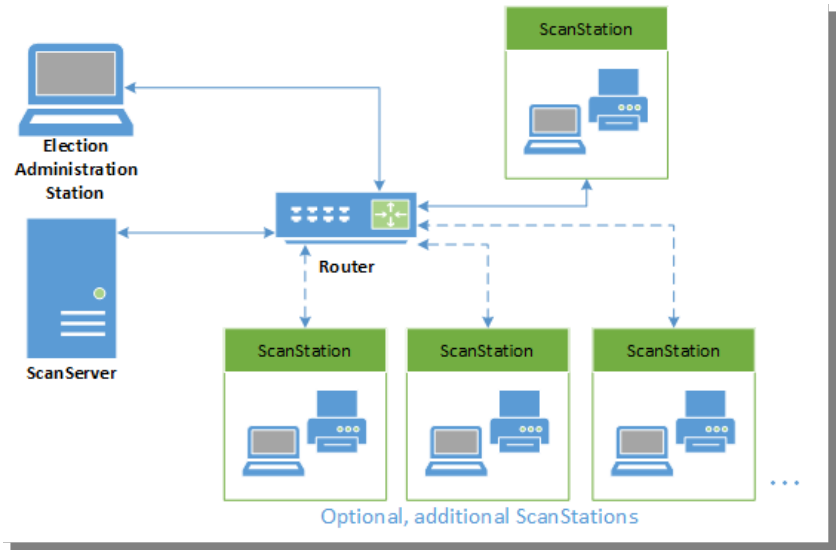

Figure 2-1. ClearCount hardware configuration diagram

The minimum configuration of hardware used in the ClearCount system involves one ScanServer, a ScanStation, and an Election Administration Station computer connected together by Ethernet cables to a single router. It is also possible to expand the closed network to include multiple ScanStations with a single ScanServer and Election Administration Station. For details on how to install and configure ClearCount, see *ClearCount Election Preparation and Installation Guide*.

The ClearCount software consists of the following components:

- **Legacy EMS Connector:** An application that independently develops the election definition from the PDF files used to print ballots for existing state-certified voting systems. The election definition takes the form of ballot definition files (BDFs).
- **Tabulator:** The Tabulator application handles ballot tabulation. The Tabulator software is stored on the ScanServer and an instance of Tabulator runs on each ScanStation to handle the ballots it is scanning. Tabulator analyzes the incoming image and transfers them to the local output folder named CBGBallotImages, from where the ScanServer retrieves them.
- **Election Database:** A centralized database that resides on the ScanServer. An election database collects and collates the output of each Tabulator instance. The resulting data is accessible through ClearCount election reports.
- **Election Reports:** A browser-based suite of reports that provides election results and analysis and allows election officials to review individual ballot images. A web server on the ScanServer serves the reports.
- **Ballot Resolver™** is a web application that allows election officials to review and appropriately resolve unreadable ballots. Election officials can review the unreadable ballots that the ClearCount system digitally outstacks, determine whether they are votable, and process them accordingly.
- **User and Election Database Management** via web applications. On the User Administration dashboard, the administrator can add, rename, or delete users, assign permissions, and change user passwords. On the Election Administration dashboard, the administrator can create or delete an election, set an election as active, and backup or restore an election.

All files that make up the ClearCount software reside on a single ScanServer that is shared by all client ScanStations. The Tabulator software on each ScanStation is read at run-time from files that reside on the ScanServer. The only software programs that have to be installed on ScanStations, apart from the Windows operating system, are the Fujitsu software and drivers required by the scanner hardware. These are described in detail in the *Election Preparation and Installation Guide*.

At scan time, the ballot images are placed first on the ScanStation. When both front and back images for a ballot arrive, they are sent together via HTTP to the ScanServer. The images are deleted from the ScanStation after they have been successfully copied to the ScanServer.

All connections between devices in the ClearCount system are private and wired. ClearCount does not utilize wireless connectivity. Wireless capabilities present on any hardware used with the ClearCount system must be disabled.

For detailed instructions on how to perform readiness testing on the ClearCount system, see the *Readiness Testing* section of *ClearCount Preparation and Installation Guide*. The ClearCount System does not have a specific test mode. Instead, jurisdictions must follow appropriate naming conventions and testing procedures to differentiate between a system test and a full election. Logic & Accuracy Tests are completed according to jurisdictional rules and regulations. The development of Logic & Accuracy Tests for a given jurisdiction occurs using the procedures for readiness testing.

Chapter 3. Operational environment of the system

This section introduces the pre-election, election, and post-election operational environment of the ClearCount system. The following process flow diagram illustrates the relationships between election phases in ClearCount. The following sections describe the activities associated with the phases.

3.1 Pre-election phase

ClearDesign, the EMS component of ClearCount, is used to create ballot styles and generate election definitions. Ballot styles are rendered as PDFs. Election definitions are exported to Ballot Definition Files (BDFs) for importing into ClearCount.

Using the NYS-certified EMS, election officials create ballot style PDFs, from which ballots are printed. Approximately 45 days before the election, officials send the ballot style PDFs, as well as the zero reports they have created, to Clear Ballot Group, using ROM media such as a DVD with a digital fingerprint sent by secure mail.

CBG uses the ballot style PDFs to create and test a unique Ballot Definition File (BDF). This zip file, in standard comma separated value (CSV) format, describes the ballot style, the precinct, each contest name and its associated choice names, as well as the coordinates of the corresponding vote targets. BDFs enable successful ballot registration (the ability to parse a ballot) and vote tabulation.

BDF names follow this convention:

stateAbbreviation_jurisdiction_electionYearAndType

For example:

ny_anycounty_2014g

The ClearCount zero report, which is used to prove that no votes have yet been cast as well as to validate the contest data in the BDFs, consists of a **Statement of Votes Cast** report that is generated after the election is created but before scanning ballots begins. This version of the report shows all candidates and issues with zeroes in all vote positions (votes, overvotes, undervotes, and non-votes).

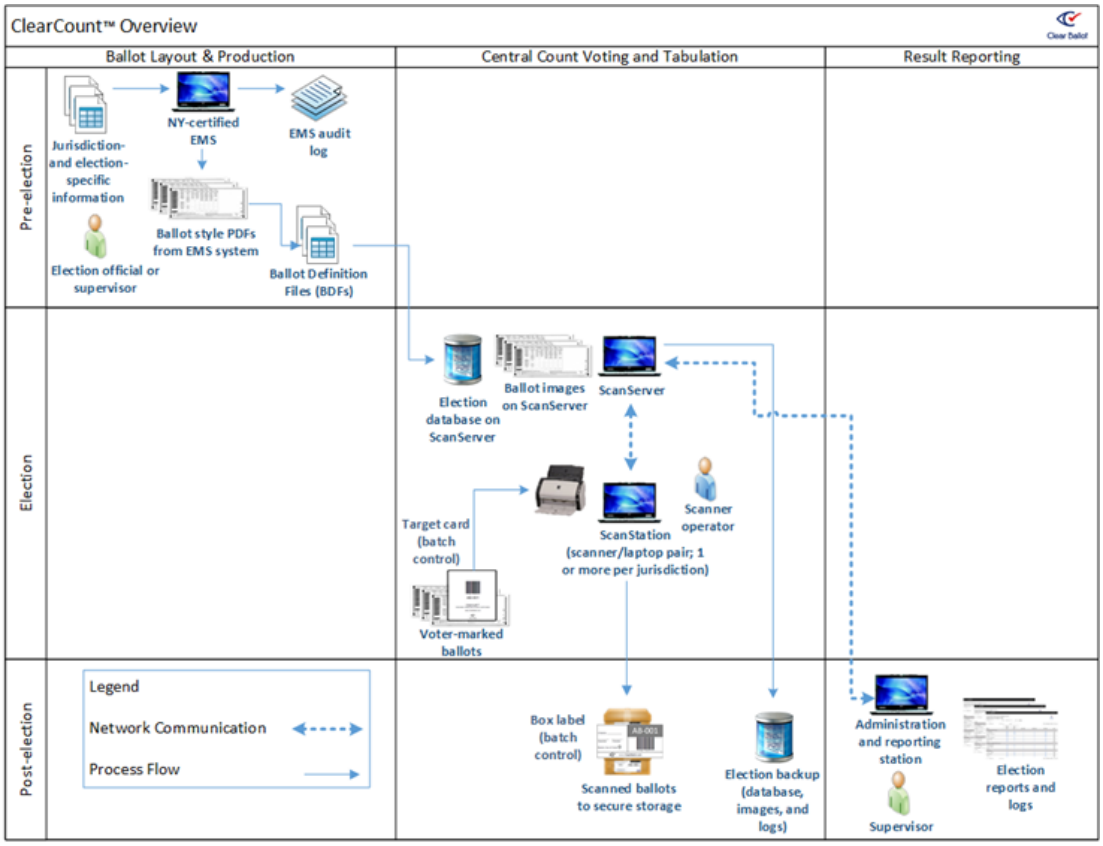

Figure 3-1. ClearCount process flow

The system administrator copies the BDF from the ROM media to a location on the hard drive on the Election Administration Station and uses it to create the election. Upon creation of the election in the ClearCount system, all information in the BDF is imported into the database.

Throughout, the jurisdiction maintains control of ballot configuration. They load and validate the BDF, which was created based upon the rules and guidance provided by them to Clear Ballot Group.

When the jurisdiction is ready to scan and tabulate the ballots, they need to do the following setup at the central count location (as described in *ClearCount Election Preparation and Installation Guide*):

- Set up the necessary equipment. This includes the ScanStations, the ScanServer™, the Election Administration Station, and the closed Ethernet network that connects them.
- Ensure the scanners and associated scanning software are configured correctly by checking the settings.
- Establish a ballot preparation area adjacent to the ScanStation network and prepare the ballots for scanning.
- Import the BDF and configure the ScanStations.

The jurisdiction arranges for the voter-marked ballots to be delivered securely to the central count location.

At this point, the election team can begin scanning the ballots.

3.2 Election processing phase

The election workflow describes the process of scanning voter-marked ballots.

First, election prep staffers prepare the ballots for scanning and affix an identifying box label to each box or other container of ballots onto which a label can be affixed. This facilitates later ballot to image traceability. They deliver boxes of ballots to ScanStations, where scanner operators are waiting for them.

Scanner operators scan the ballots from each box preceded by their identifying target card. A target card includes a bar code and ID that is used to form the name for each ballot image file. The ID on the box label and target card match. When finished, the scanner operator returns the scanned ballots to the box or other container and initials the box label to indicate that the ballots have been scanned. Prep staffers pick up the box of scanned ballots and deliver it to the designated location.

These steps are repeated until all ballots are scanned.

3.3 Post-election phase

In the ClearCount system, when the polls close, the system administrator switches the election from append mode (during which it accepts new database ballot records or new ballot images via scanning) to modify mode (in which a user with the proper permissions can modify existing contents of the election that allow remaking or correcting but no newly-scanned records may be added). (Upon certification, the system administrator switches the election to read-only mode.) Instructions on how to change the election mode appear in theClearCount *Election Administrator's Guide*. Any decision to reopen the polls can be implemented by someone with dbadmin status. The decision is a jurisdictional decision.

After the close of polls, election results are served in the form of a suite of Election Reports on the ScanServer, and may be accessed by the users with the appropriate permissions on the Election Administration Station computer. This computer is connected using a closed, wired Ethernet. Viewing the reports is logged in the web event log.

Users can also export the results to a CSV file.

3.4 Audit logging and reporting

Audit logging and reporting take place during election processing as well as afterward, as long as election officials continue to access reports. The ClearCount system creates two logs:

- For each election, ClearCount creates a separate Election Activity Log. This log tracks Tabulator start, processing, and end events, probable target card and scanning error identification, and server warning and error messages.
- The ClearCount system generates a single Web Event Log that tracks all users' web-based actions for all of that jurisdiction’s elections. This includes accessing Election Reports or individual ballot images, remaking ballots, and making changes to the election database(s) and/or users.

Reports may be read online or printed, as well as exported along with an election.

For additional information on logging in the ClearCount System, including the logging of events in Windows and logins to the Linux operating system, see *ClearCount Election Administrator’s Guide* and *ClearCount Preparation and Installation Guide*.

Chapter 4. COTS components in the ClearCount system

This section introduces the COTS hardware, software, and communications services utilized in ClearCount.

For details on the COTS components used in the ClearCount System, see *ClearCount Approved Parts List* and *ClearCount Hardware Specification*.

4.1 COTS hardware

All of the hardware used by the ClearCount system is unmodified COTS.

4.2 COTS software

With a single exception, all third-party software included in ClearCount is unmodified. The one exception is the modification to the Python TWAIN module discussed with reference to the GetScannerInfo executable in the *ScanStation software items* section of *ClearCount Software Specification*.

All software (ClearCount and third-party) is stored in the CBG source control management system, as described in the *Configuration control procedures* chapter of *ClearCount Configuration Management Plan*.

4.3 COTS communications services

All hardware in a ClearCount system is connected using a private wired Ethernet. Wireless connections are not supported. In order to distribute election reports, election officials may either attach a temporary drive in order to burn a CD or DVD on an Election Administration computer, or transfer the results to a flash memory drive. It is not necessary to connect a printer to the Election Administration Station computer.

Chapter 5. Interfaces among internal components

This section describes interfaces between the components in the ClearCount system.

5.1 Physical interfaces among system components

ClearCount utilizes the following physical interfaces between components:

- ScanStation computer to scanner:
  - fi-6670 and the fi-6800 scanners - USB 2 cables only
  - fi-7180 scanner - USB 2 or 3 cables
- ScanStation computer to router - wired Ethernet
- ScanServer computer to router - wired Ethernet
- Election Administration Station computer to router - wired Ethernet

For details on hardware components, see *ClearCount Hardware Specification*.

5.2 Functional interfaces between components

For details of the functional interfaces between components, see the *Software overview* and *Interfaces* sections of *ClearCount Software and Design Specification*.

5.3 Benchmark directory structure

For the ClearCount benchmark directory structure, see the *Software Item Identification* section of *ClearCount Software Design and Specification*.

Chapter 5. System performance

This chapter provides information about ClearCount system performance in the following areas:

- Performance characteristics of each operating mode and function
- Quality attributes
- Provisions for dependable operation
- Design constraints, applicable standards, and compatibility requirements
- Specification of a reliably detectible mark by an optical scanner

System performance

The key measurements of performance of the ClearCount system fall into three categories:

- Scanner hardware
- Ballot registration and scoring
- Image saving

Performance is the same in Test and Election modes.

5.4 Scanner hardware performance

The following table shows the sustained scanning speeds of supported Fujitsu scanner models for various ballot sizes.

Table 5-1. Scanning speeds for various ballot sizes

Scanner model	Sustained ballots per hour by ballot size in inches						Typical county size (central count)
	8.5 x 11	8.5 x 14	8.5 x 17	8.5 x 18	8.5 x 19	8.5 x 22	
fi-6800	5500*	4500	3500	3100	3000	2600	Large (>100K voters)
fi-6670	4300*	3500	3000	2800	2400	2100	Medium (25K to 100K voters)
fi-7180	2000	1700	1400	1400	1300	1200	Small (< 25K voters)

* Scanning ballots in a landscape format

5.5 Ballot registration and scoring performance

In system tests, ballot registration and scoring were limited by the speed at which the scanners could process images.

In volume tests, where images were tabulated directly without being limited by a scanner, 8.5 inch x 17 inch ballot images were registered and scored at rates over 6,000 ballots per hour.

5.6 Image saving performance

Image saving is currently limited by the rates at which the configured scanner and the Tabulator can each process ballots. In system tests, image saving kept pace with ballot registration and scoring performance. The system was able to save ballots at rates over 6,000 ballots per hour.

Chapter 6. Quality attributes

ClearCount ensures product quality in the following areas.

- Provisions for safety, security, privacy, and continuity of operation
- Design constraints
- Applicable standards
- Compatibility requirements

For additional quality characteristics, including reliability, maintainability, availability, usability, and portability, see *ClearCount Hardware Specification*, *Design, construction, and maintenance characteristics*.

6.1 Safety

The ClearCount system and recommended methodology do provide safety risks to operators, as confirmed by the *ClearCount Quality Assurance Program*.

All of the COTS hardware used in the system has been tested by a Nationally Recognized Testing Laboratory (NTSL) and is marked with a UL or other safety mark.

Fujitsu, manufacturer of the unmodified COTS scanners used in the ClearCount system, provides a hard-copy *Safety Precautions Guide* is provided with each scanner. (A copy of the *Safety Precautions Guide* for each scanner model supported is included in the TDP.)

ClearCount addresses physical safety in its product documentation concerning setup, maintenance, and scanning. For details, see:

- *ClearCount Election Preparation and Installation Guide*
- *ClearCount System Maintenance Manual*

6.2 Security

The ClearCount system and recommended methodology ensure security through the following mechanisms:

- Access control
- Use of a closed network
- Security-minded administrative practices

For full details on ClearCount security, see *ClearCount Security Specification*.

6.3 Privacy

Because ClearCount is a central-count system, there is no direct voter interaction. Voter privacy while voting is not at issue. The voted ballots that ClearCount processes at the central count location contain no personally identifying information. Ballot-handling practices are the responsibility of the jurisdiction. Therefore, the ClearCount system does not include any special privacy measures.

6.4 Continuity of operation

ClearCount runs on scalable, distributed hardware. To ensure continuity of operation, jurisdictions should ensure they have redundant hardware capacity that undergoes full pre-election L&A testing. If continuity of operation is a high priority, the jurisdiction should avoid running the ClearCount system on a single scanner.

For detailed information on ensuring continuity of operation, see *ClearCount System Maintenance Manual*, especially the *Spare or backup devices* section.

6.5 Design constraints

The following table summarizes the testing of design constraints by Clear Ballot:

Table 6-1. Testing of design constraints

Characteristic	Tested ballot limit	Tested election limit
Ballot positions (vote targets)	Ballot with 3880 positions	1.05 million
Ballot styles	N/A	120,000

Database size and acquisition of ballot image files are constrained by available space on hard drives.

ClearCount can read ballots printed on stock ranging from 57 lb Bristol Vellum up to 110 lb index.

6.6 Applicable standards

The ClearCount software is run on unmodified COTS computers and scanners. Each piece of COTS hardware used in the ClearCount system has an FCC Class B declaration of conformity and a CE Mark affixed to it.

- The FCC Class B Mark certifies that an electronic product's electromagnetic interference falls under the limits set by the Federal Communications Commission of the United States in its Declaration of Conformity and Certification procedures of 1998.
- The CE Mark (1993) indicates a product's conformance to relevant European Union regulations.

CBG recommends that COTS equipment also bear a safety testing mark by an OSHA Nationally Recognized Testing Laboratory (NRTL), such as the Underwriters Laboratory UL mark.