



Clear Ballot

ClearVote 1.4 EAC

System Overview

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Clear Ballot Part Number: 100071-10010

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Document history

Date	Description	Version	Authors
05/15/2017	Initial submission to EAC	1.0	Joni G. McNutt
06/16/2017	Minor updates for vote-by-mail campaign	1.0.1	Joni G. McNutt
09/25/2017	Added preface; updated The Clear Ballot approach, the ClearVote, the ClearDesign, the ClearCount, and the ClearCast sections; minor edits	1.0.2	Joni G. McNutt
10/18/2017	Updated the System limits section	1.0.3	Joni G. McNutt
10/23/2017	Updated the System limits section	1.0.4	Joni G. McNutt
11/03/2017	Updated table in "Maximum vote targets per ballot card"	1.0.5	Joe Srednicki
11/06/2017	Updated "Maximum vote positions per card"	1.0.6	Joe Srednicki
11/07/2017	Updated the System limits and the ClearDesign sections	1.0.7	Joni G. McNutt
11/08/2017	Updated the System limits	1.0.8	Joni G. McNutt
11/17/2017	Updated ClearDesign section	1.0.9	Joni G. McNutt

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Preface

This document describes each ClearVote product and shows how they interact to provide a complete end-to-end election solution. In addition, it provides information about data flows, security and encryption, and other important program features.

Audience for this document

This document is intended for election officials and voting system test laboratory (VSTL) staff, as well as for informed citizens with an interest in election technology.

For more information

For more information about the ClearVote system, visit our website at clearballot.com, or contact us at info@clearballot.com.

Chapter 1. The ClearVote product family

The ClearVote system consists of four products that are certified as an integrated application, as well as an independent, automated election audit solution.



Figure 1-1. The ClearVote product family

Table 1-1. ClearVote products by election phase

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

Chapter 2. The Clear Ballot approach

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 America?
- And, 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 ClearVote, the nation's first modern voting system.

Chapter 3. ClearVote: An end-to-end solution

ClearVote consists of five independent system components:

- **ClearDesign**—election management system
- **ClearAccess**—in-person accessible voting solution
- **ClearCast**—in-person precinct-scan voting solution
- **ClearCount**—central scan and tabulation, results consolidation and reporting
- **ClearAudit**—independent, automated audit

The diagram below shows the simple relationship between the independent systems. The ClearVote products exchange data in fully documented, zipped, plain text comma-separated values (CSV) files. These files are digitally signed for protection against tampering.

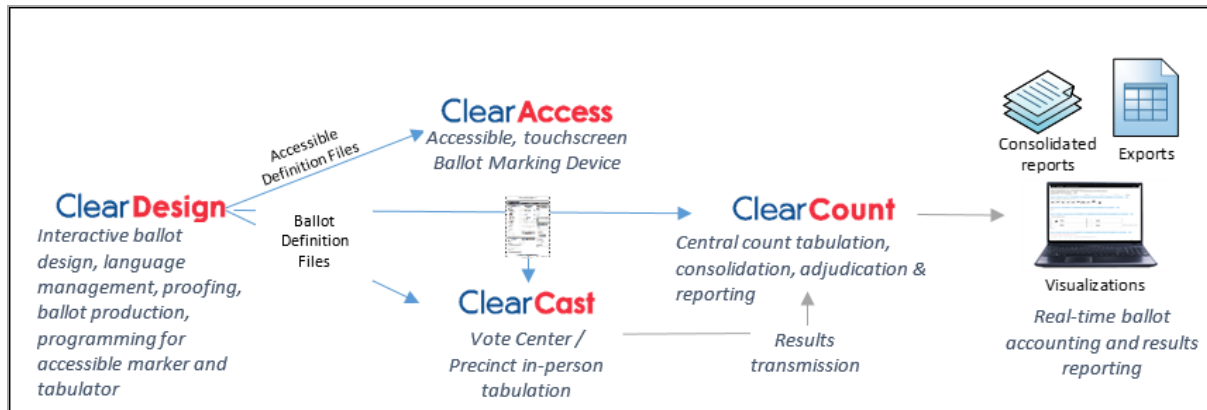


Figure 3-1. Relationship between ClearVote products

Security and encryption

Security is built in to the ClearVote system design and informs every technical decision. All networked components operate solely on closed, wired Ethernet connections. No component is ever connected to the Internet.

The ballot design system (ClearDesign) and the tabulating and reporting system (ClearCount) undergo a thorough hardening process to prevent unauthorized access. The accessible voter terminals (ClearAccess) and the precinct tabulation unit (ClearCast) are also hardened with a focus on the threat model associated with polling place deployment. The role-based security model establishes the minimum level of access (least privilege) that individual users are granted so that the jurisdiction can maintain control and accountability over system use.

When data is in motion in the ClearDesign and ClearCount systems, which operate on closed networks, it is encrypted to guard against interception, unauthorized viewing of the data traffic, and tampering with that data.

Safety, reliability, and maintainability

The ClearVote system runs on well-established commercial, off-the-shelf (COTS) scanning and computing hardware, and printers. Developed for a broad market, these products are robust, reliable, and well-supported.

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

System limits

The following table summarizes the testing of ClearVote system limits by Clear Ballot.

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
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.



Chapter 4. ClearDesign: Election management system

The ClearDesign election management system is used for these tasks:

- Create and import jurisdiction data
- Lay out, proof, and produce both paper and accessible ballots in all supported languages
- Program the other ClearVote products

Election department staff can design ballots independently and interactively, proof their design (including accessible ballots), lay out and review one or all ballot styles (including HTML-based accessible ballots), generate PDFs for ballot-printing companies and ballot-on-demand printers, and generate the election definition files that program the other components.

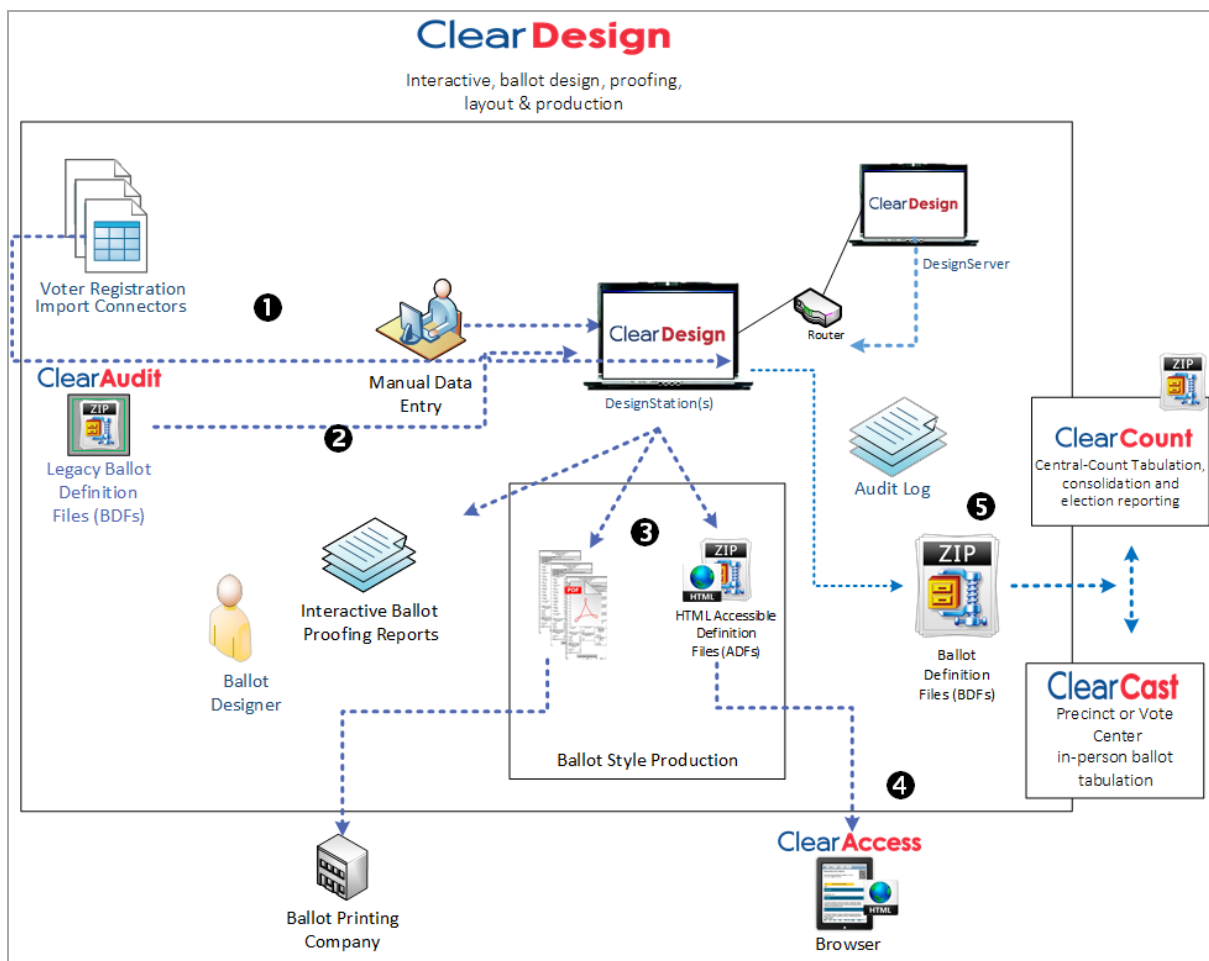


Figure 4-1. ClearDesign data flow

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

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

ClearDesign allows the user to define the various options 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
- Rotation
- Special contests, such as straight-party voting

ClearDesign 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.

ClearDesign provides over 70 reports that can be used to validate and proof the election definition to ensure the election is defined correctly.

The ClearDesign system consists of the following physical components—all of which are unmodified COTS hardware and are connected via closed, wired Ethernet connections:

- **DesignServer**—A laptop or desktop computer that runs the ClearDesign software on Linux, and hosts its election database and the web server that serves its election reports. The DesignServer is an appliance and cannot be interacted with directly. All user access (including administration) occurs via a DesignStation by a user with the proper credentials.

- **DesignStations**—One or more computers running the Microsoft Windows operating system with a browser-based user interface. The DesignStation is used to connect to the DesignServer and create the ballots.
- **Router**—Used to connect the DesignStations to the DesignServer via a wired, closed Ethernet.

Chapter 5. ClearAccess: Accessible-voting solution

The ClearAccess system is an in-person ballot-marking system designed to ensure access for all voters by incorporating best practices recommended by the disability community, such as use of the Anywhere Ballot.

The ClearAccess solution runs on a COTS touchscreen computer. The voter can privately and independently indicate his or her choices on the touchscreen, review the selections, make corrections as necessary, print a machine-marked ballot, and cast it into a ballot box. The ClearAccess software logs all transactions without compromising voter privacy, and stores no results data because its output is a marked paper ballot.



Figure 5-1. An example ClearAccess setup

The ClearAccess ballot-marking system consists of one or more ballot-marking stations having the following physical components (all of which consist of standalone, unconnected, unmodified COTS hardware):

- **Ballot-marking device (BMD)**—A laptop or tablet computer running the ClearAccess software as a browser application in kiosk mode. At each ballot-marking station, a web server serves HTML pages for voting and administration. The BMD runs the Microsoft Windows operating system. The BMD can be optionally enclosed in a protective bezel that does not affect its operation, but further secures it from tampering while at the polling place.
- **Privacy screen**—A folding screen to ensure privacy for the voter during ballot marking.
- **Personal assistive technology (PAT) devices**—Each ballot-marking station includes these assistive input devices:
 - Sip-and-puff headset
 - Accessible keypad
 - Headphones
- **Ballot style transfer device**—USB drive
- **Printer**—A laser or inkjet printer capable of printing two-sided ballots. Jurisdictions will find that the superior mark-recognition algorithms in the ClearCast and ClearCount software allows the use of less expensive printers to produce the ballots. Because the traditionally tight tolerances, for example, for front-to-back registration, are relaxed in the ClearVote system, a wider variety of printers can be used to print the voted ballots.

Ballots voted on the ClearAccess system are scanned by the ClearCast system or the ClearCount system for the next phase: tabulation, consolidation, and reporting.

Chapter 6. ClearCast: Precinct-voting solution

The ClearCast precinct-count optical-scan voting system is built with modern software tools. Its hardware and software design eliminates the need to separate ballots mechanically when they are unreadable, overvoted, undervoted, or have write-in candidates.



Figure 6-1. A ClearCast system

For precinct voting, the ClearCast tabulator maintains three copies of election data: one on its internal solid-state storage drive, and two on removable USB drives.

Along with in-person precinct ballots, the ClearCast tabulator can process the paper ballots that are printed on the ClearAccess ballot-marking system.

The ClearCast tabulation unit is built entirely from COTS parts. The 31-pound unit sits on a tabletop, and with its 9-by-14-inch footprint, can be transported by passenger car or truck.

The ClearCast ballot box is collapsible and produced from ripstop nylon. Translucent strips on two sides of the box allow election officials to see that the box is filling and anticipate the need to change or empty it.

When polls close, the ClearCast unit produces a results tape either by precinct or as a summary report of all results in the scanner. A second tape showing the images from marked write-in areas can also be printed. As with the ClearAccess system, ballots tabulated on the ClearCast system are transmitted via one of the redundant USB drives to the central ClearCount system for the next phase: consolidation and reporting.

Chapter 7. ClearCount: Central tabulation, consolidation, and reporting

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 precinct tabulators
- Generating operational reports and contest reports
- Logging the activities and data required for independent audits

The system consists of the following physical components (all of which are 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 a Linux operating system (a configured version of which is installed with the ClearCount software).
- **ScanStations**—One or more computer/scanner pairs used to scan and tabulate ballots. The ScanStation computers use the Microsoft Windows operating system.
- **Router**—Used to connect the ScanStations and the election administration stations to the ScanServer using a closed, wired Ethernet. (Optionally, a switch can be added for larger elections that require more ScanStations.)
- **Election administration stations**—One or more Microsoft Windows laptop or desktop computers installed with browser software. Election officials use this computer to manage elections and users, to monitor and interact with election reports, and to adjudicate unreadable cards. System administrators use it to monitor the ClearCount system.

Ballot inventory and control

ClearCount technology allows for ballot control. Ballot batches are identified by a target card, which contains a bar code and is the first card scanned in a batch. By combining the value of the bar code 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 the 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.

Vote Visualization

The ClearVote voting system includes 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) systems use white-light, grayscale scanning to make the highest quality card images. The following image shows voted ovals for a contest. Each oval links to a high-resolution card image.

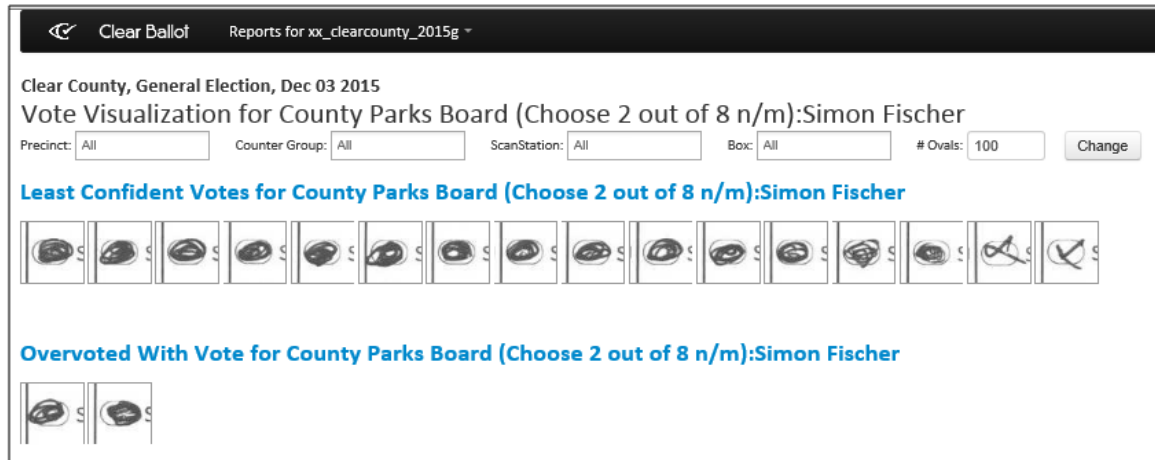


Figure 7-1. ClearVote's Vote Visualization

The Dashboard

The Dashboard is the ClearCount information center. This real-time 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.

Election Data		Visual Resolution of Unreadable Cards	
Election Phase	scanning	Unreadable card images needing resolution	0
Ballot type	CBG1	Unreadable cards resolved & adjudicated	0
Approx ballot image dimensions	8.5" x 11.0"	Unvotable unreadable cards (could be resolved by rescanning 0 boxes):	
# Card styles	8	Occluded or incomplete unreadable images	0
# Contests	14	Scanned unreadable images with multiple overlapping cards	0
# Choices	52	Unreadable resolved as a non-ballot	0
# Parties	6	Unreadable cards	0
# Counter groups	3		
# Precincts	5	Card Reconciliation	
# Precincts and card styles	8	Cards automatically adjudicated	40
Ballot Scanning Operations		Adjustments to card count for Unreadables & Modifications	
Scan date	2016-03-22	Unreadable cards	0
Tabulation date	2016-06-14	Resolved as a non-ballot	0
Tabulator software version	Version 1.1.0 2015-11-19 12:51:01	Estimated additional cards in multiple overlapping cards	0
# Scanners	2	Adjustment to card count from visual resolution	0
# Boxes scanned	7		
# Precincts scanned	5 out of 5	Final Total Card Count	40
# Cards automatically adjudicated	40		
# Pages judged to be non-ballots	8		
# Unreadable cards (0.00% rate)	0		
# Pages scanned (ballots and non-ballots)	48		
# Cards that are fully blank	0		

Figure 7-2. The ClearCount Dashboard

From the Dashboard, officials can examine operations in detail, such as the performance of individual ScanStations, and can access and adjudicate unreadable cards. All election and contest data is updated as each ballot is scanned. When tabulation is complete, officials generate the reports required to complete the canvass and certify the election.

Chapter 8. ClearAudit: Independent, automated election audit system

In addition to providing products that cover each phase of an election, Clear Ballot offers an independent, automated election audit solution—ClearAudit.

The ClearAudit system completely verifies an election. The election definition from the voting system is selected from the library of PDFs produced by the jurisdiction’s EMS. Every card image is captured using COTS scanners. The ClearAudit software then independently tabulates the vote and compares the detailed results to those of the official tally produced by the primary voting system. Any differences—especially results that could change the outcome—are instantly highlighted and can be analyzed by election officials. Clear Ballot uses intelligent technology to interpret voter marks, to confirm the accuracy of the results, to identify any errors, and to build public confidence in the election system itself.

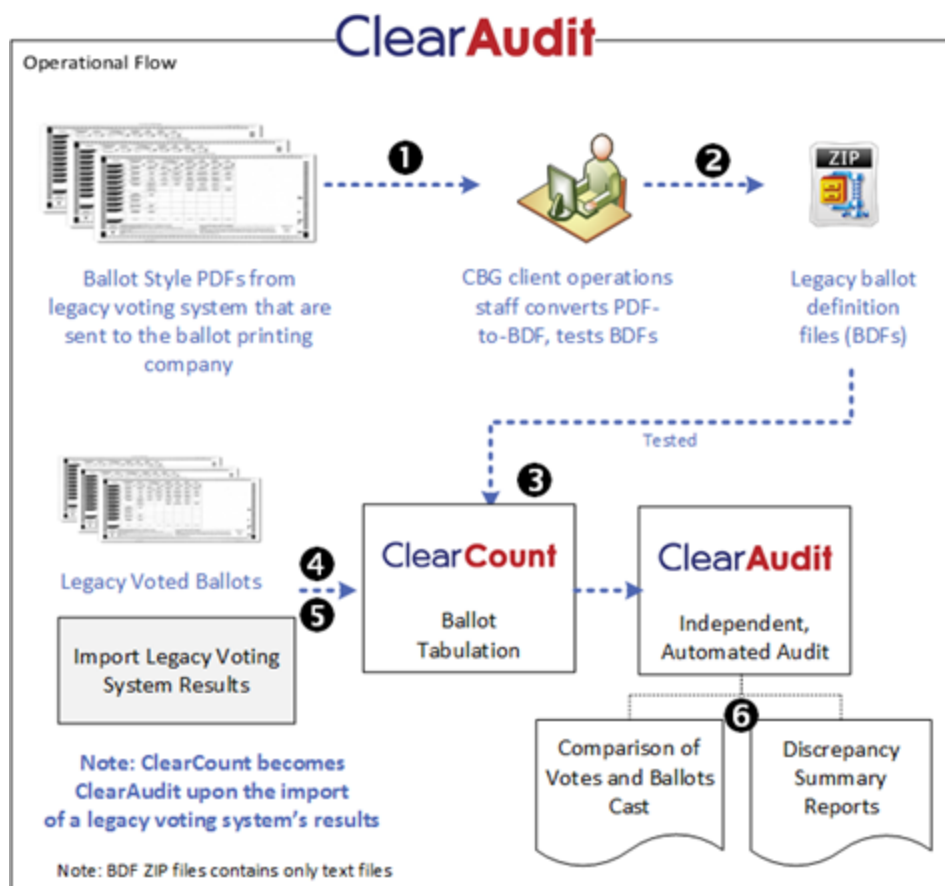


Figure 8-1. ClearAudit operational flow

ClearAudit shares a code base with ClearCount and its physical setup is similar. Like ClearCount, the ClearAudit hardware consists of one or more laptop computers connected to COTS scanners, connected by a router to a single ScanServer computer.