

# InnoVote CardReader

## Hardware Requirements Overview

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# 1. Introduction

## 1.1. Purpose.

The purpose of this document is to communicate an overview of the hardware requirements for the InnoVote CardReader ballot-scanning machine. The document provides a description of required hardware components and basic hardware operations that the components must be able to perform.

In addition to an overview of the hardware design, this document also provides basic requirements for low-level driver design functions. This hardware design proposes that CardReader be designed to interface with commercially available personal computers through a Universal Serial Bus (USB) connection, a design that necessitates a hardware driver. InnoVote CardReader Software (reference [1]) will use this driver to control the hardware.

The intended audience of this document is the designer and any other persons interested in the project, including election reform activists, computer security professionals, hardware designers, political figures with an interest in election reform, and potential buyers of the design.

## 1.2. Scope.

InnoVote CardReader is one component of an interoperable line of products. It is a ballot-scanning machine that contains the required hardware features for CardReader Software [ref. 1] to operate. CardReader is similar in most respects to existing ballot scanners; however, as described in section §2.4, it contains features that do not exist on all currently manufactured products.

The computer that controls the scanner is a kiosk system with no keyboard or mouse and no software applications other than system processes and the CardReader Software. In addition to its single USB connection with the scanner, it contains an Ethernet adapter, over which it exchanges data with the precinct's central computer and the authentication server for the precinct. Except for error detection and logging, all operations on CardReader are initiated either by an authenticated data transmission from the precinct computer or by data input from the CardReader scanner.

The proposed design does not require the development of new technologies. It uses existing hardware components and technologies. For this reason, this document does not provide detailed electrical schematics for the hardware, but rather, an overview of the basic hardware operations that CardReader must perform to be fully compatible with CardReader Software and equivalent software and thus provide the full accountability and security that is warranted.

### 1.3. Definitions, Acronyms, and Abbreviations.

- CardReader Hardware: The ballot-scanning equipment that CardReader Software will control.
- CardReader: The software that controls the InnoVote CardReader hardware, whose attributes are defined in reference [1]. (“CardReader” always refers to the software; when the hardware is intended, the term “CardReader hardware” is used.) “CardReader-compatible” refers to a software product that can perform the same functions as InnoVote CardReader.
- County computer: The computer in a County central election office that is running central tabulation software, in this document assumed to be ReliaVote CS.
- County: Refers to either a county or parish in a state.
- Database: Refers to any relational database stored on an InnoVote product. All InnoVote products’ databases use the same relational schema, so “Database” can refer to any database used by an InnoVote software product.
- Database management system: The software that is used to establish, configure, and maintain a database.
- Error: A condition in which the system either experiences an exception or in which an attempt to violate a security rule occurs.
- Exception: An error in which the system fails to function as expected.
- InnoVote: Working name of the product line.
- IP: Internet Protocol, the standard protocol used in the Internet. IP version 6 is the preferred version for InnoVote products.
- Packet: The basic unit of data transmitted over a network. A packet’s size depends on various characteristics of the network, as well as the amount of data being sent.
- Precinct computer: The computer in a Precinct that is running ReliaVote PE.
- Precinct: Refers to the physical site at which people cast ballots on Election Day, whether *called* a “precinct” by local government or not.
- RAM: Random Access Memory, the memory of a computer that requires electrical power to retain data. Synonymous in this document with “temporary memory.”
- ReliaVote CS: ReliaVote Central Server, the software operating on a central computer in each county, whose attributes are defined in reference [5]. “ReliaVote CS-compatible” refers to a software product that can perform the same functions as the ReliaVote Central Server software.
- ReliaVote PE: ReliaVote Precinct Edition, the software operating on a computer in each precinct, whose attributes are defined in reference [6]. “ReliaVote PE-compatible” refers to a software product that can perform the same functions as the ReliaVote Precinct Edition software.
- TCP/IP: Transmission Control Protocol/Internet Protocol, the protocols used for most data transfers on the Internet at the transport and network layers.

## 1.4. References.

- [1] Thead, E. *InnoVote CardReader Functional Design*, 2005.
- [2] Thead, E. *InnoVote Database Access Matrix*, 2005.
- [3] Thead, E. *InnoVote Database Detailed Design*, 2005.
- [4] Thead, E. *InnoVote Network Detailed Design*, 2005.
- [5] Thead, E. *InnoVote ReliaVote Central Server Functional Design*, 2005.
- [6] Thead, E. *InnoVote ReliaVote Precinct Edition Functional Design*, 2005.
- [7] Thead, E. *Security Analysis of InnoVote Products*, 2005.

## 1.5. Overview.

The remainder of this document is organized in the following fashion:

Section 2: Contains a brief overview of operations that the hardware will need to perform and a high-level description of necessary hardware components.

Section 3: Contains a detailed description of hardware operations, including the hardware components that will be involved in each operation.

## **2. Overall Description**

### **2.1. Product Functions.**

The CardReader system must be able to perform the following hardware operations:

1. Power on
2. Perform standard mathematical and string operations on data
3. Write data to temporary memory
4. Read data from temporary memory
5. Detect a USB connection
6. Accept input from a USB connection
7. Send output over a USB connection
8. Queue output when no computer is connected via USB
9. Accept input from an optical bar code scanner
10. Accept input from an optical ballot scanner
11. Regulate the temperature of the system
12. Power off

### **2.2. Hardware Components.**

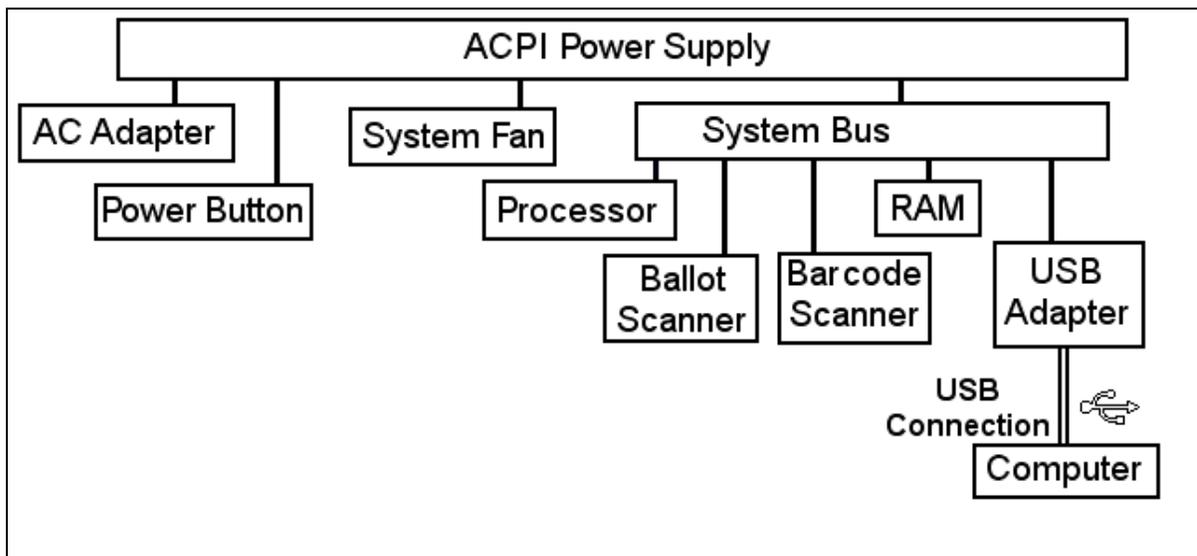
The CardReader ballot scanning machine will require at least the following hardware components:

- Advanced Configuration and Power Interface (ACPI)-compliant power supply
- AC adapter
- Power on/off button
- Cooling fan
- System bus
- Microprocessor
- Random-access memory (RAM)
- Ballot scanner
- Bar code scanner
- USB adapter

### 2.3. Component Diagram for CardReader Hardware.

Figure 1 shows a diagram of the components that the CardReader hardware requires. Boxes represent hardware components. Connecting lines represent bidirectional data flow between one component and another, or, in the case of the ACPI Power Supply and the hardware devices to which it is directly connected, the connecting lines represent the flow of electrical current from the power supply to another device.

**Figure 1: Component Diagram.**



### 2.4. Differences Between CardReader and Existing Ballot Scanners.

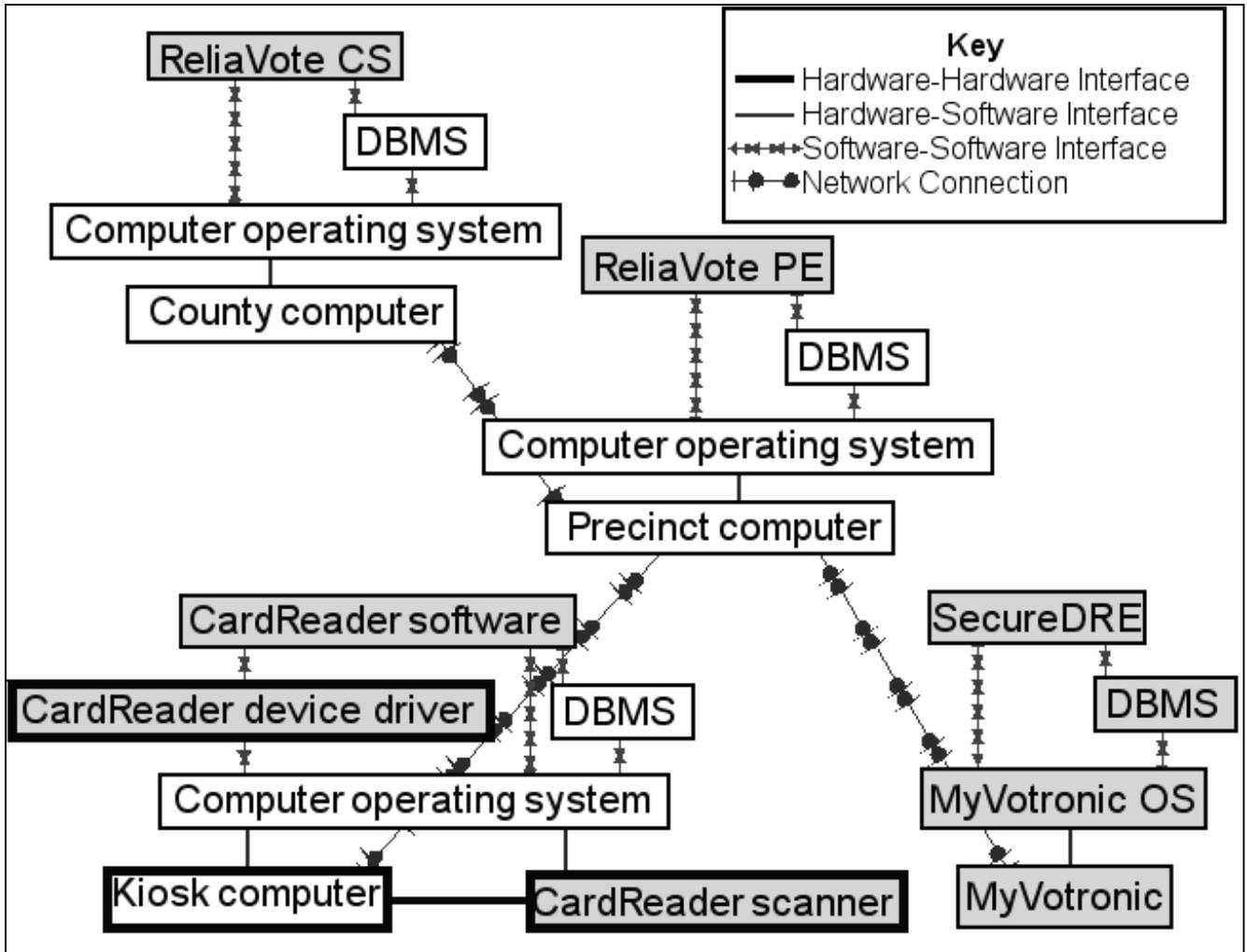
The CardReader hardware design is similar to existing ballot scanners, with two notable exceptions:

- Processor: Although it is controlled by a driver that is installed on a computer, CardReader contains its own microprocessor that will, when necessary, perform data operations.
- Bar code scanner: For accountability purposes, CardReader Software stores a record of individually cast votes. The CardReader Hardware contains a bar code scanner that reads a ballot bar code and converts it to a digital/binary format.

## 2.5. Deployment of the Product.

Figure 2 shows the deployment diagram for all InnoVote products and necessary third-party components. Items that this document describes are surrounded with thick lines.

**Figure 2: Deployment Diagram.**



## 3. Specific Requirements

### 3.1. Functional Requirements.

The features described in this section are operations that are necessary for correct and useful operation of the CardReader ballot-scanning machine and therefore the CardReader software that uses it.

#### 3.1.1. System Feature 1: Power on

##### 3.1.1.1. Purpose of Feature

This feature allows the system to receive electrical current from an alternating-current source and convert it to direct current. All other operations of the system require electrical current to perform.

##### 3.1.1.2. Required Hardware Components

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- Power on/off button

#### 3.1.2. System Feature 2: Perform mathematical and string operations on data

##### 3.1.2.1. Purpose of Feature

This feature allows the system to perform mathematical and string operations on data. All operations should be able to be reduced to one or more true-false operations that can then be mapped to an electrical circuit. Essentially, this feature requires that the system (external to the kiosk computer) contain at least one processor and a means of sending data and operations to the processor.

##### 3.1.2.2. Required Hardware Components

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- System bus
- Microprocessor

### **3.1.3. System Feature 3: Store data in memory**

#### **3.1.3.1. Purpose of Feature**

This feature allows the system to store data in temporary memory (RAM) for future processing. It is assumed that the data will originate either from hardware input or from an operation performed by the microprocessor on existing data.

#### **3.1.3.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- System bus
- Microprocessor
- RAM

### **3.1.4. System Feature 4: Retrieve data from memory**

#### **3.1.4.1. Purpose of Feature**

This feature allows the system to retrieve data from RAM for processing.

#### **3.1.4.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- System bus
- Microprocessor
- RAM

### **3.1.5. System Feature 5: Detect USB connection**

#### **3.1.5.1. Purpose of Feature**

This feature allows the processor on the CardReader scanning equipment to detect the presence of a USB connection to an external computer before it transmits any other data to the computer.

#### **3.1.5.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- System bus
- Processor
- USB adapter, with or without computer connection present

### **3.1.6. System Feature 6: Accept input over a USB connection**

#### **3.1.6.1. Purpose of Feature**

This feature allows the system to accept input over a USB connection. This input will have originated on the USB-connected computer with CardReader Software and will be in the form of a device driver function for the bar code or ballot scanner.

#### **3.1.6.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- USB adapter with computer connection present

### **3.1.7. System Feature 7: Send output over a USB connection**

#### **3.1.7.1. Purpose of Feature**

This feature allows the system to send output over a USB connection. This output will be destined for the USB-connected computer with CardReader Software.

#### **3.1.7.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- USB adapter with computer connection present

### **3.1.8. System Feature 8: Queue output when no USB connection is available**

#### **3.1.8.1. Purpose of Feature**

This feature allows the CardReader hardware to queue output in memory when the CardReader processor fails to detect a USB connection to an external computer.

#### **3.1.8.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- Processor
- System bus
- RAM

### **3.1.9. System Feature 9: Accept input from a bar code scanner**

#### **3.1.9.1. Purpose of Feature**

This feature allows the system to accept input from an optical bar code scanner and copy it into memory for processing. Numerous operations of CardReader Software require the successful operation of this feature.

#### **3.1.9.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- System bus
- Microprocessor
- RAM
- Bar code scanner

### **3.1.10. System Feature 10: Accept input from a ballot scanner**

#### **3.1.10.1. Purpose of Feature**

This feature allows the system to accept input from an optical ballot scanner and copy it into memory for processing. Numerous operations of CardReader Software require the successful operation of this feature.

#### **3.1.10.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- System bus
- Microprocessor
- RAM
- Ballot scanner

### **3.1.11. System Feature 11: Regulate temperature of hardware components**

#### **3.1.11.1. Purpose of Feature**

This feature allows the system to detect the temperature of hardware components and cool the system as necessary by operating the fan or other cooling device.

#### **3.1.11.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- Cooling fan

### **3.1.12. System Feature 12: Power off**

#### **3.1.12.1. Purpose of Feature**

This feature allows the system to shut off all hardware operations by cutting electrical power to the system bus.

#### **3.1.12.2. Required Hardware Components**

The following components of §2.2 are necessary for correct execution of this feature:

- ACPI power supply
- AC adapter
- Power on/off button

## **3.2. Performance Requirements.**

The features described in this section are requirements that are necessary for CardReader to operate in a reasonable amount of time or under normal conditions.

### **3.2.1. Performance Requirement 1: Send and receive USB I/O quickly**

Several operations of CardReader Hardware require that data be sent over a USB connection. Because of the data-intensive nature of the CardReader Software's operations, the data transfers over USB must be completed quickly. The designer suggests the use of the USB 2.0 standard in the CardReader Hardware.

### **3.2.2. Performance Requirement 2: Process data quickly**

Some operations of CardReader require the use of a microprocessor to manipulate data. Additionally, the computer to which the CardReader scanner is connected will also require a microprocessor. Because of the data-intensive nature of CardReader Software's operations, both processors must be able to process data very rapidly.

### **3.2.3. Performance Requirement 3: Store and retrieve data from memory quickly**

Several operations of CardReader require that data be stored (written) and retrieved (read) from memory or RAM. As with Performance Requirements 1 and 2, the data-intensive nature of CardReader's operations necessitate that all data operations involving the RAM be performed rapidly.

### **3.2.4. Performance Requirement 4: Function in broad temperature range**

The CardReader Hardware needs to operate correctly in a broad temperature range. It cannot be assumed that the machine will always operate in conditioned locations; therefore, it needs to operate correctly when the surrounding air temperature is in the range of -40 to +125 degrees Fahrenheit.