

Open Source Voting

Arthur M. Keller

UC Santa Cruz and Open Voting Consortium

Alan Dechert

Open Voting Consortium

Amy Pearl

Software Innovations

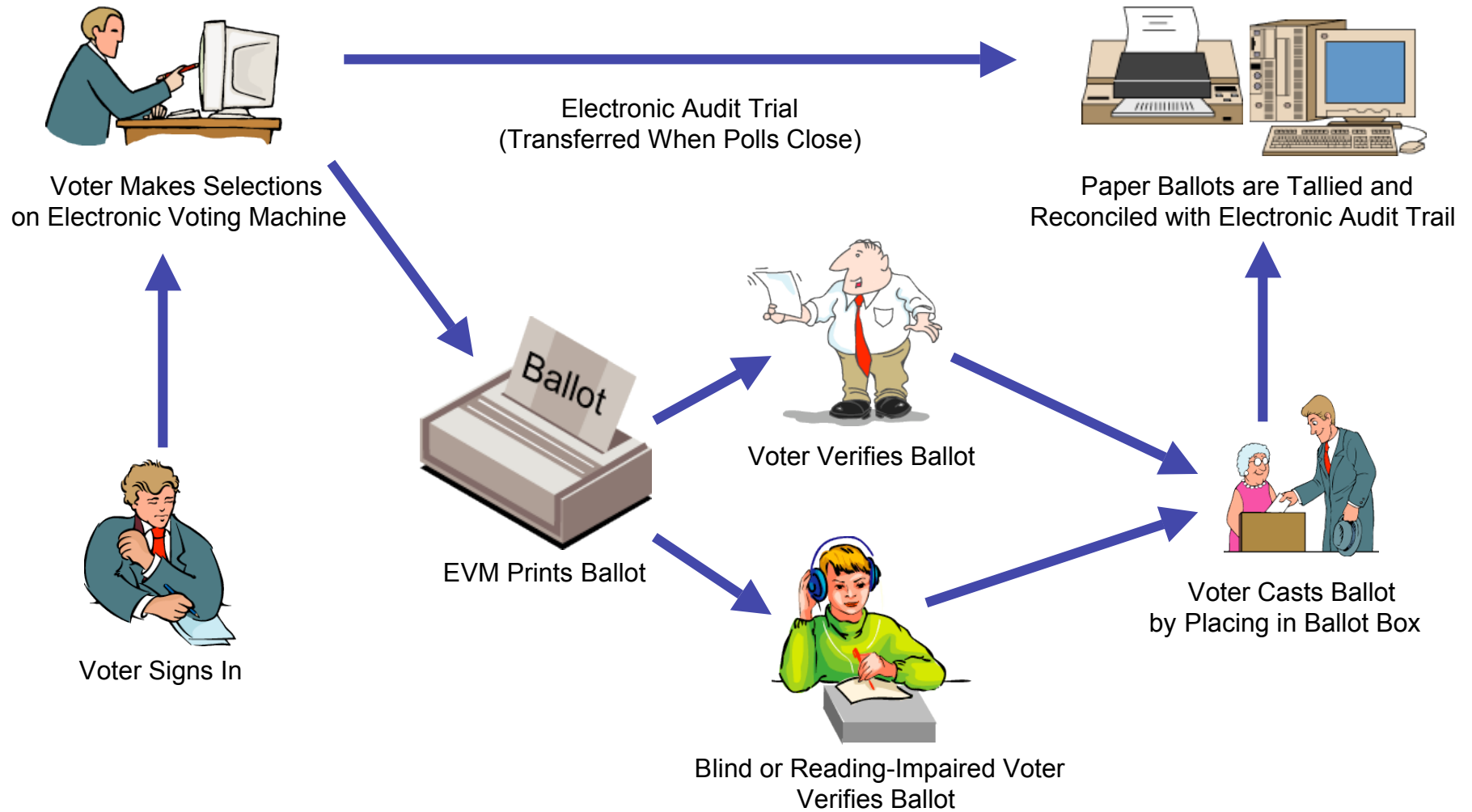
Outline

- Concept
- In-Precinct Architecture
- Central Tabulating System
- Central Reporting System
- Bulk Scanning
- In-Precinct Scanner

Concept

- Secret Ballots Tallied in Public
incompatible with
Voting Machines and Tabulators whose
inner workings are **Trade Secrets**
- Open Voting Consortium
created to promote
Public Software for Public Elections

In-Precinct Architecture



Voter Sign-in Station

- Voter signs in.
- Poll worker gives voter a token enabling one vote for the correct ballot type (party/precinct).
- Token does not reveal voters identity.
- Token could be:
 - Pre-printed ballot stock, smart card,...

Electronic Voting Station

- Commodity PC in secure enclosure.
- Boots off Knoppix (Linux) CD-R, containing all software and data.
- Printer for the “official” paper ballot.
- Produces an electronic audit trail, kept on flash RAM and written in random order to same CD-R for reconciliation and archive.
- Touch screen, mouse, keyboard, or ATM-style buttons.
- Multiple language support.
- Electronic Ballot Printer (EBP).

Sample User Interface

GENERAL ELECTION • SANTA CLARA, CA • NOVEMBER 7, 2000 • PRECINCT 2216

TO VOTE, MAKE YOUR SELECTIONS BY POINTING ON YOUR CHOICES (OR POINTING AND CLICKING IF USING MOUSE). TO DE-SELECT, POINT AGAIN.

INSTRUCTIONS	CONGRESSIONAL	LEGISLATIVE	COUNTY
<p>a. TO VOTE FOR a candidate whose name is on the ballot, point or click on the name.</p> <p>b. TO VOTE FOR a write-in candidate, select "WRITE-IN CANDIDATE" and proceed to enter letters from the on-screen typewriter.</p> <p>c. CHECK YOUR SELECTIONS on the screen then select "PRINT MY BALLOT." If the printout looks incorrect, take it to a poll worker for disposal and return to make a new one. If the printout is the way you want it, proceed to the ballot box to deposit your ballot and sign out on the roster.</p>	<p>UNITED STATES SENATOR (Vote for One)</p> <p><input type="radio"/> FRANCES E. WILLARD GREEN</p> <p><input type="radio"/> LUCY STONE LIBERTARIAN</p> <p><input type="radio"/> KARL MENNINGER DEMOCRAT</p> <p><input type="radio"/> JANE ADDAMS WORKERS</p> <p><input type="radio"/> CLARENCE DARROW SOCIALIST</p> <p><input type="radio"/> WILLIAM LLOYD GARRISON LABOR</p> <p><input type="radio"/> SIDNEY HILLMAN REPUBLICAN</p> <p><input type="radio"/> [] WRITE-IN</p> <p>U.S. REPRESENTATIVE TENTH CONGRESSIONAL DISTRICT (Vote for One)</p> <p><input type="radio"/> IGNACE PADEREWSKI DEMOCRAT</p> <p><input type="radio"/> LILLIAN HELLMAN REPUBLICAN</p> <p><input type="radio"/> [] WRITE-IN</p>	<p>STATE SENATOR FIRST SENATORIAL DISTRICT (Vote for One)</p> <p><input type="radio"/> ROBERT INGERSOLL DEMOCRAT</p> <p><input type="radio"/> MARTIN LUTHER REPUBLICAN</p> <p><input type="radio"/> BARBARA JORDAN GREEN</p> <p><input type="radio"/> [] WRITE-IN</p> <p>STATE ASSEMBLY THIRD ASSEMBLY DISTRICT (Vote for One)</p> <p><input type="radio"/> DON LEE REPUBLICAN</p> <p><input type="radio"/> LANGSTON HUGHES DEMOCRAT</p> <p><input type="radio"/> [] WRITE-IN</p>	<p>PROPOSED COUNTY CHARTER AMENDMENT</p> <p>CHARTER AMENDMENT REFERENDUM NO. 1</p> <p>TWO TERM LIMIT FOR COUNTY COMMISSIONERS</p> <p>Shall the Santa Clara County Charter be amended to add Article II, Section 2.2.A provisions limiting Commissioners to two terms?</p> <p><input type="radio"/> YES for Approval</p> <p><input type="radio"/> NO for Rejection</p> <p>CAT CATCHER (Vote for up to Three)</p> <p><input type="checkbox"/> REGIS PHILBIN</p> <p><input type="checkbox"/> OPRAH WINFREY</p> <p><input type="checkbox"/> HOWARD STERN</p> <p><input type="checkbox"/> CHARLIE ROSE</p> <p><input type="checkbox"/> ROSIE O'DONNELL</p> <p><input type="checkbox"/> CARRIE FISHER</p> <p><input type="checkbox"/> STEVEN SPIELBERG</p> <p><input type="checkbox"/> QUEEN LATIFAH</p> <p><input type="checkbox"/> EDDIE MURPHY</p> <p><input type="checkbox"/> [] WRITE-IN</p>
<p>ELECTORS FOR PRESIDENT AND VICE PRESIDENT</p> <p>(A vote for the candidates will actually be a vote for their electors)</p> <p>REPUBLICAN</p> <p><input type="radio"/> GEORGE WASHINGTON, For President ABRAHAM LINCOLN, For Vice President</p> <p>DEMOCRAT</p> <p><input type="radio"/> THOMAS JEFFERSON, For President, HARRY S. TRUMAN, For Vice President</p> <p>GREEN</p> <p><input type="radio"/> RACHEL CARSON, For President, JOHN MUIR, For Vice President</p> <p>LIBERTARIAN</p> <p><input type="radio"/> SUSAN B. ANTHONY, For President, BETSY ROSS, For Vice President</p> <p>SOCIALIST</p> <p><input type="radio"/> V. I. LENIN, For President, KARL MARX, For Vice President</p> <p>REFORM</p> <p><input type="radio"/> MARTIN LUTHER KING, For President, JOHN ANDERSON, For Vice President</p> <p>WORKERS</p> <p><input type="radio"/> HELLEN KELLER, For President, AMELIA EARHART, For Vice President</p> <p>WRITE-IN CANDIDATE</p> <p><input type="radio"/> [] For Vice President</p> <p><input type="radio"/> [] For Vice President</p>	<p>STATE</p> <p>TREASURER (Vote for One)</p> <p><input type="radio"/> TOM COSGROVE REPUBLICAN</p> <p><input type="radio"/> JOHN GALLAGHER DEMOCRAT</p> <p><input type="radio"/> [] WRITE-IN</p> <p>ATTORNEY GENERAL (Vote for One)</p> <p><input type="radio"/> DEWITT CLINTON GREEN</p> <p><input type="radio"/> CHARLES PARNELL REPUBLICAN</p> <p><input type="radio"/> THOMAS P. O'NEILL JR. DEMOCRAT</p> <p><input type="radio"/> [] WRITE-IN</p> <p>COMMISSIONER OF EDUCATION (Vote for One)</p> <p><input type="radio"/> CHRISTIAN DOPPLER REPUBLICAN</p> <p><input type="radio"/> CARL SAGAN DEMOCRAT</p> <p><input type="radio"/> [] WRITE-IN</p>	<p>PROPOSED CONSTITUTIONAL AMENDMENTS AND OTHER PUBLIC MEASURES</p> <p>NO. 1 CONSTITUTIONAL AMENDMENT ARTICLE X, SECTION 19 (Initiative)</p> <p>CALIFORNIA TRANSPORTATION INITIATIVE FOR STATEWIDE SOLAR POWERED MAGNETIC LEVITATION SYSTEM</p> <p>To reduce traffic and increase travel alternatives, this amendment provides for development of a high speed solar powered magnetic levitation system to run along Interstate 5. Construction to begin November 1, 2004.</p> <p><input type="radio"/> YES for Approval</p> <p><input type="radio"/> NO for Rejection</p> <p>NO. 2 CONSTITUTIONAL AMENDMENT ARTICLE XII, SECTION 18 CALIFORNIA UNIVERSAL HEALTH CARE</p> <p>To improve accessibility to quality health care and to reduce overall health care costs, this amendment provides for the establishment of a single payer Health Care System for all Californians. Implementation to take effect January 1, 2005.</p> <p><input type="radio"/> YES for Approval</p> <p><input type="radio"/> NO for Rejection</p>	<p>COUNTY COMMISSIONER (Rank up to eight choices beginning with your first)</p> <p>1 2 3 4 5 6 7 8</p> <p><input type="radio"/> [] DAVID PACKARD</p> <p><input type="radio"/> [] WILLIAM HEWLETT</p> <p><input type="radio"/> [] STEVE JOBS</p> <p><input type="radio"/> [] STEVE WOZNIAK</p> <p><input type="radio"/> [] WILLIAM SHOCKLEY</p> <p><input type="radio"/> [] GORDON MOORE</p> <p><input type="radio"/> [] PHILIP KAHN</p> <p><input type="radio"/> [] []</p> <p><input type="radio"/> [] WRITE-IN CANDIDATE</p> <p><input type="button" value="Clear Selections"/></p>
			<p>FINISHED!</p> <p><input type="button" value="PRINT MY BALLOT"/></p>

Reading Impaired Interface

- Auditory and visual output of ballot choices and selections made.
- Additional input modes.
- Universal design.
- Multiple language support.

Paper Ballot

- Electronic Voting Station prints a paper ballot.
- Paper ballot must be *cast* to be tallied.
- Voter can verify paper ballot by reading or listening to paper ballot.
- Contains security markings to avoid forgeries or ballot stuffing.
- Includes a barcode for easy computer reading. Will also use OCR font.

Sample Ballot

8859

8859

OFFICIAL BALLOT
GENERAL ELECTION
Santa Clara County, CA Precinct 2216
2004-11-04

President	→	Thomas Jefferson
Vice President	→	Harry S. Truman
Senator	→	Clarence Darrow
U.S. Representative	→	Lillian Hellman
Treasurer	→	Linus Torvalds
Attorney General	→	Dewitt Clinton
Commis. of Education	→	Richard Stallman
State Senate	→	Martin Luther
State Assembly	→	No preference indicated
Transportation Initiative	→	Yes
Health care initiative	→	Yes
Term limits	→	No
Cat Catcher	→	Oprah Winfrey Steven Spielberg
County Commissioner	→	1 - Steve Jobs 2 - William Hewlett 3 - David Packard 4 - Gordon Moore

6988

July 19, 2005

Open Source Voting

9

Privacy Folder

- Hides human readable portion of ballot after voter prints ballot until it is cast.
- Allows barcode to be scanned by Ballot Verification Station while still in folder.
- Voter hands privacy folder with ballot to poll worker, who removes ballot (face down) and places it in ballot box.

Ballot Box

- Physically secure container.
- Ballots must be cast in ballot box to be counted.
- Ballot boxes opened in view of public for tallying.

Ballot Verification Station

- Scans ballot barcode.
- Speaks ballot choices for verification by reading-impaired.
- Can display ballot choices for anyone else.

Ballot Reconciliation Station

- Reconciles printed ballot against electronic audit trail.
- Reads CD-R from Electronic Voting Stations.
- Scans paper ballots.
- Compares them.
- Reconciles spoiled ballots and count of provisional ballots.

Alternatives for Ballot Reconciliation System

- Could do all scanning at the end of the day.
- Could scan ballots incrementally through day to ensure they are readable.
- Could also scan optical scan (opscan) ballots.
 - Good way to transition from existing system.
 - Supports hand marked ballots.
 - Also supports Electronic Ballot Marker (EBM) design (e.g., AutoMark).

Box for Spoiled Ballots

- If voter spoils a ballot, ballot is marked spoiled and placed in box for spoiled ballots.
- Spoiled ballots are reconciled along with cast ballots against electronic audit trail.

Box for Provisional Ballots

- Voter may cast a provisional ballot.
 - If voter not on voter roll, or if voter was sent an absentee ballot.
- Voter given a distinctive voter token to identify ballot to be provisional.
- When voter is ready to cast ballot, paper ballot is placed in a sealed envelope that lists the details necessary to determine whether the ballot should be counted.

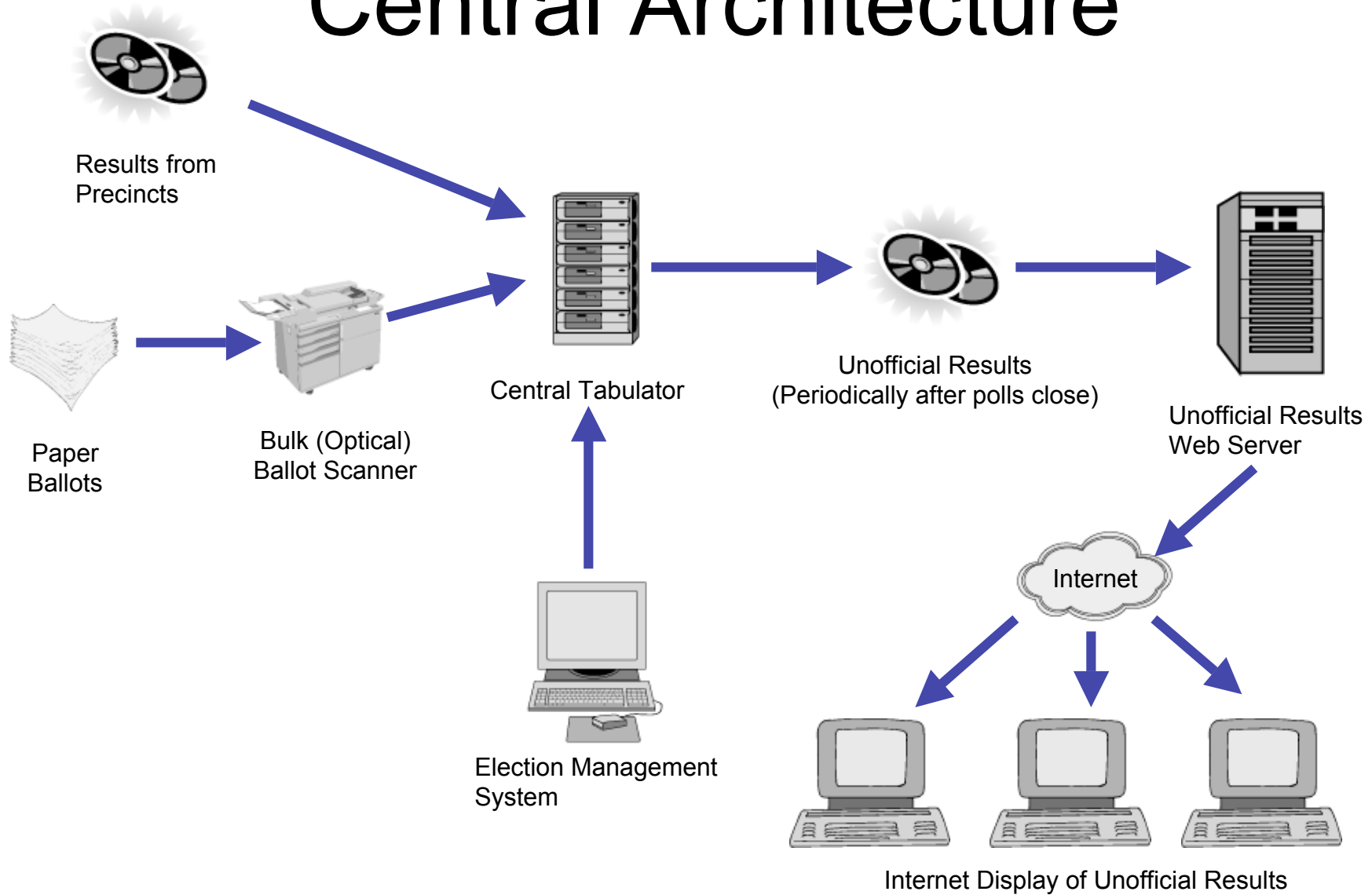
Absentee and Manual Polling-Place Ballots

- Use paper optical-scan system.

Central Tabulating System

- Reliable, secure, auditable voting machines are not enough.
- We also need reliable, secure, auditable canvassing (counting) systems used centrally.

Central Architecture



Central Tabulating System

- Vote Tabulator.
- Election Management System.
- Official Reporting System.

- Unofficial Reporting System.

- Central Opscan Ballot Reader.

Vote Tabulator

- Database of *every* vote, anonymously.
- Log of all access by user and time.
- Production-quality database.
- Supports ranked preference voting (e.g., IRV, STV).
- Could replace Vote Tabulator for Diebold, ES&S, Sequoia,.....
- Full logging of use, support for recounts.
- IEEE 1622-compliant.

Election Management System

- Database of candidates and measures (contests and choices), jurisdictions, precincts, parties, primary info.
- Provides election data for electronic voting machines, precinct tabulators, central tabulators.
- Full logging of use.
- IEEE 1622-compliant.

Official Reporting System

- Reports official results for election officials and certification process.
- Does not release results (other than counts of voters) before polls close.
- Full logging of use.
- Support for recounts.
- IEEE 1622-compliant.

Unofficial Reporting System

- Periodically after polls close, central tabulation system burns CD or DVD with updated summary results.
- CD or DVD is physically carried (“sneaker net”) to unofficial reporting system and loaded in.
- Unofficial reporting system provides web access to election results, including:
 - Precinct-by-precinct totals.
 - Regular votes vs. absentee and provisional ballots.
 - Report of which provisional and which absentee votes are counted.
 - Allows reconciliation of totals posted at precinct with totals in tabulation system.
- IEEE 1622-compliant.

Central Opscan Readers

- Batch scans absentee ballots, provisional ballots, opscan or OVC-style ballot.
- Reads image of ballot.
- Determines where the marks are without knowing what they mean.
- Logs location of all the marks on a ballot.
- Interprets marks based on election management system data to create electronic ballot image.
- Supplies electronic ballot image to central tabulator.
- Full logging and support for automated recounts.
- IEEE 1622-compliant.

Current Status

- Prototype built of precinct-based system.
- Demonstration covered on TV, radio, and newspapers.
- Available on Source Forge as EVM2003.

Roll-out plan

- Develop prototype of central tabulator.
- Develop production version of central tabulator, election management system, and reporting systems.
- Develop production quality version of central optical scan ballot reader.
- Develop production quality version of precinct-based optical scan ballot reader.
- Develop OVC Electronic Ballot Printer system.

Conclusion

- Give election officials more choices.
- Enable best-of-breed voting systems.
- Enable competition in services and follow-on support.
- Build open source voting systems vendors can adopt.
- Cheaper, more reliable and secure, auditable, and more trustworthy.