ON MARK SENSE SCANNING

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- In Defense of Paper
- Scanning Technology
- What is a Vote?
- Second Chance Voting
- Human Factors
- Handicapped Access
In Defense of Paper

Proponents of DRE Slam Paper
Opponents of DRE Slam the Alternatives
If you listen to both, why vote?

The Australian Secret Ballot

<table>
<thead>
<tr>
<th>OFFICIAL BALLOT</th>
<th>U.S. CONGRESS</th>
</tr>
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<tbody>
<tr>
<td>(Random County, Some State)</td>
<td>(vote for one)</td>
</tr>
<tr>
<td>President (vote for one)</td>
<td>S. Rayburn</td>
</tr>
<tr>
<td>O. G. Washington</td>
<td>J. G. Cannon</td>
</tr>
<tr>
<td>O. A. Lincoln</td>
<td>N. Longworth</td>
</tr>
<tr>
<td>(write in)</td>
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- Trivial Technology
- But
- A Sophisticated System
- Abandoned by 1920's in Urban U.S.
- Revived as Punched Card & Mark Sense Ballots in 1960's
DEFENDING PAPER

THREAT

BALLOT BOX STUFFING
COMPARE NO. OF POLLBOOK SIGNATURES
WITH NO. OF BALLOTS

BALLOT BOX SUBSTITUTION

POLLBOOK ALTERATION
ALL PROCESS OPEN TO PUBLIC OBS.
ADVERSARY JOINT CUSTODY
-MEMBERS OF OPPOSING PARTIES

BALLOT ALTERATION DURING COUNT
NO PENCILS OR ERASERS FOR COUNTERS
WHITE GLOVES & MANICURES

CLERICAL ERRORS
SORT BALLOTS BY MARK
COUNT BALLOTS, NOT MARKS
-EXACTLY LIKE COUNTING MONEY

BIASED COUNTING

ADVERSARY COUNTING TEAMS
SORT STACKS BY DISAGREEMENT
-FORCE BIAS INTO THE OPEN

CHAIN VOTING
NUMBER BALLOT STUBS
Scanning Technology

Definitions

Voting Target
- G. Washington

Prescribed Mark
- G. Washington

Index Marks

Sensitive Area

Discrete Sensor Scan
- LED
- Photosensor
- Ballot Direction of Scan
- One LED/Photosensor pair per track on the ballot

Fax Bar Scan

Grey Scale Scan
- Pixelize ballot
- Visible light vs infrared
- Color image scan

Alternatives

The arrow may be used as an index mark

Fiducial marks and interpolation may be used
What is a Vote?

The Machine Model

- Whatever the scanner recognizes current certification only requires that prescribed marks be distinguished from unmarked targets

Enumerate Acceptable Marks

- Post 2000 Florida law mismarkings are responses to bad instruction normal variation in skill normal errors (predictable)

Consistant Usage

- Michigan law recognizes that we are all expert at reading and marking paper (if not blind)

Complicating Factors

- Marginal marks may read differently if re-read - even by same machine
- Marks seen by eye may not be seen by IR scanner
- Many scanners accept marks not enumerated in law or forbidden by law

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Hesitation Mark - a particular problem?
SECOND CHANCE VOTING

PRECINCT COUNT OPTICAL SCAN
- Tabulate votes at the precinct
- Print precinct totals
- Record electronic ballot images
- Transmit images & totals Sneakernet & Modem wireless
- Return ballots with overvotes & blanks for repair by voter

CENTRAL COUNT OPTICAL SCAN
- Tabulate votes at county office
- Less protection against classic fraud
- No second chance?

CENTRAL COUNT MACHINES CAN
- Sort overvotes & blanks for attention by the board of resolution

This gives better treatment of postal ballots!
HUMAN FACTORS

- Illegible or difficult to interpret ballots have been traditional using all voting technologies!

- Bad ballot design has measurable consequences

  Butterfly Ballot
  Race split over 2 columns
  Vote for group
  Traditional Florida instruction in races with running mates
  To vote, mark like this
  O A. Lincoln (Rep)

  To vote, connect the arrow
  A. Lincoln ↓

  Division between columns
  |  O Jones  |  O Smith  |  O Cheng |

- Human factors standards?
  Type size (in points?)
  Viewing angle
  Nothing about details!
  Left to vendors
  Left to states
  Left to counties

RESEARCH FOCUS
  DRE
  Handicapped Access

~30% of the vote is postal!
~30% of precincts use DRE!
HANDICAPPED ACCESS

• LOW TECH - LOW COST
  TACTILE BALLOT
  PROVEN FOR SIMPLE ELECTIONS
  NEEDS WORK FOR GENERAL ELECTIONS
  USEFUL FOR MANY DISABILITIES

• HIGH TECH - HIGH COST
  TOUCH SCREEN BALLOT MARKER
  VOGUE/ES&S AUTOMARK
  TOUCH SCREEN & AUDIO INTERFACE
  USEFUL FOR MANY DISABILITIES

• HIGH TECH - LOW COST
  JONES PATENT APPLICATION
  TACTILE BALLOT
  MARK-SENSING WAND
  GRAPHICS TABLET
  + MICROCONTROLLERS
  = $200 in lots of 10
NEWS FLASH

MIAI MI ES&S IVOTRONIC

JUNE 6 2003
ORLANDO SUAREZ CONCLUDES THAT I VOTRONIC BUG MAKES AUDIT TRAIL USELESS FOR CERTIFYING ELECTION

OCTOBER 10 2003
SUAREZ REPORTS LOSS OF VOTE IMAGE DATA

THE GOOD NEWS
MIAMI HAS COMPETENT EMPLOYEES WHO ARE LOOKING SERIOUSLY AT THEIR VOTING SYSTEM

THE BAD NEWS
THE DROP-DEADLINE FOR CHANGE TO THE POLLWORKER MANUAL HAS PASSED SO THE IVOTRONIC WILL BE USED IN THE AUGUST PRIMARY & NOVEMBER 2004

IS THIS SAFE?
YES, WITH RESERVATIONS

WHAT PROTECTIVE MEASURES ARE NEEDED
LOTS
THE iVOTRONIC

386 CPU
ROM
SRAM

2M FLASH EEPROM 1

2M FLASH EEPROM 2

2M FLASH EEPROM 3

IR
SERIAL PORT

PEB
PIC
FLASH EEPROM

PATHS TO ELECTION MANAGEMENT SYSTEM

PRINTOUT AT PRECINCT MODEM SNEAKERNET

SUMMARY DATA ONLY

COMPLETE 2M DUMP OF EEPROM

LAPTOP

CF CARD

SNEAKERNET

PRIMARY DATA PATH EXAMINED DURING DEVELOPMENT CERTIFICATION

SECONDARY PATH

AFTER THOUGHT

Slide 10
2 M FLASH EEPROM CONTENTS

BALLOT IMAGES

AUDIT LOG ENTRIES

CONFIG #SN
...

NOT IDENTICAL IN EEPROMS 12 & 3

MOVES FOR WEAR LEVELING

IF EXTRACTED BY SERIAL LINK
ALWAYS FROM EEPROM #1

IF EXTRACTED FROM CF CARD
FROM LOWEST ROM WITH
CORRECT CHECKSUM

ELECTION MANAGEMENT SYSTEM
DOES NOT KNOW HOW TO FIND
CONFIG DATA FROM EEPROMS 2, 3

RESULT: WRONG #SN IF
CHECKSUM ERROR!

FACT: WRONG SN'S LIKELY TO COLLIDE
RESULT: ELECTION MANAGEMENT
SYSTEM DISCARDS IMAGES & LOG
FOR ONE SYSTEM!
DEFENSIVE MEASURES

3. Reconcile number of voters with number of ballots
4. Print & post precinct totals when polls close
5. Reconcile printed record with election management system output
6. Guard chain of custody of all data
7. Parallel testing

NOTE

Audit data extracted to laptop is OK if background check routine does not report error even if there is a checksum error.

Ballot images & audit log entries extracted to compact flash are OK even if DSN reads wrong.

Correct DSN is used as file name on 2MB EEPROM image file on compact flash card.

CAVEAT

If what I have been told is correct!

MORAL

Afterthoughts attract bugs
Interfaces attract bugs
Fault recovery code attracts bugs
All three combined here!