

DIMACS
MAY 27-04

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

OFFICIAL BALLOT Random County, Sonastate	
INSTRUCTIONS: TO vote for a candidate, make an X in the oval beside the name of the candidate you prefer	
PRESIDENT (vote for one)	U.S. CONGRESS (vote for one)
<input type="radio"/> G. Washington	<input type="radio"/> S. Rayburn
<input type="radio"/> A. Lincoln	<input type="radio"/> J.G. Cannon
<input type="radio"/> _____ (write in)	<input type="radio"/> _____ (write in)

- 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

DEFENSE

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

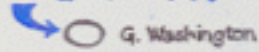
CHAIN VOTING

NUMBER BALLOT STUBS

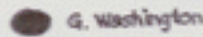
SCANNING TECHNOLOGY

DEFINITIONS

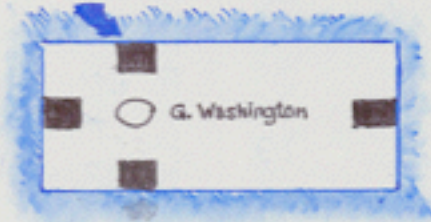
VOTING TARGET



PRESCRIBED MARK

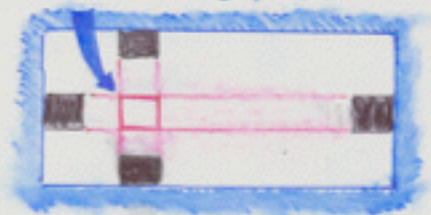


INDEX MARKS



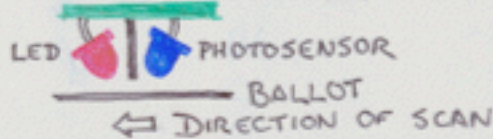
THE ARROW MAY BE USED AS AN INDEX MARK

SENSITIVE AREA



FIDUCIAL MARKS AND INTERPOLATION MAY BE USED

DISCRETE SENSOR 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

WHAT IS A VOTE?

THE MACHINE MODEL

- WHATEVER THE SCANNER RECOGNIZES
CURRENT CERTIFICATION ONLY
REQUIRES THAT PERSCRIBED 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

	○ S. Rayburn	
✓ G. Washington	⊗ J.G. Cannon	← HESITATION MARK - A PARTICULAR PROBLEM!
⊗ A. Lincoln	○ N. Longworth	
⊖ (write in)	∅ (write in)	

Slide 5

SECOND CHANCE VOTING

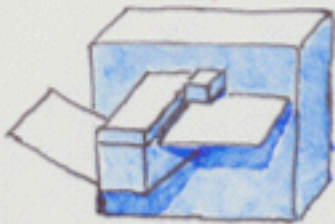
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PRECINCT COUNT OPTICAL SCAN



- TABULATE VOTES AT THE PRECINCT
- PRINT PRECINCT TOTALS
- RECORD ELECTRONIC BALLOT IMAGES
- TRANSMIT IMAGES & TOTALS SNEAKERNET
MODEM
WIRELESS
- RETURN BALLOTS WITH OVERVOTES
BLANK
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 ●

○ A. LINCOLN (REP)

TO VOTE, CONNECT THE ARROW

A. LINCOLN ← →

DIVISION BETWEEN COLUMNS

| ○ JONES | ○ SMITH | ○ 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

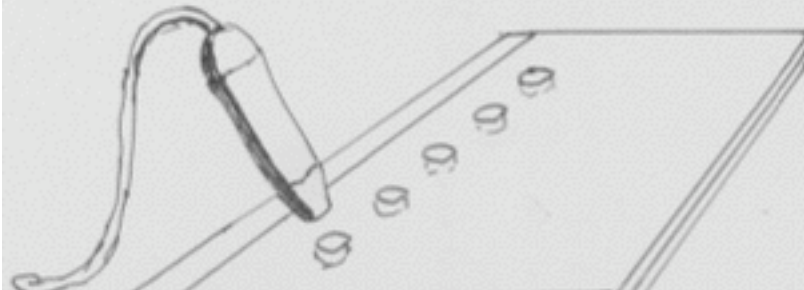
VOGUE/ES&S AUTO MARK
TOUCH SCREEN & AUDIO INTERFACE
USEFUL FOR MANY DISABILITIES

- HIGH TECH - LOW COST

JONES PATENT APPLICATION

TACTILE BALLOT
MARK-SENSING WAND
GRAPHICS TABLET
+ MICROCONTROLLERS

= \$200 in lots of 10



NEWS FLASH

MIAMI ES&S iVOTRONIC

- JUNE 6 2003
ORLANDO SUAREZ CONCLUDES THAT iVOTRONIC 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-DEAD DEADLINE FOR CHANGE TO THE POLLWORKER MANUAL HAS PASSED SO THE iVOTRONIC WILL BE USED IN THE AUGUST PRIMARY & NOVEMBER 2004

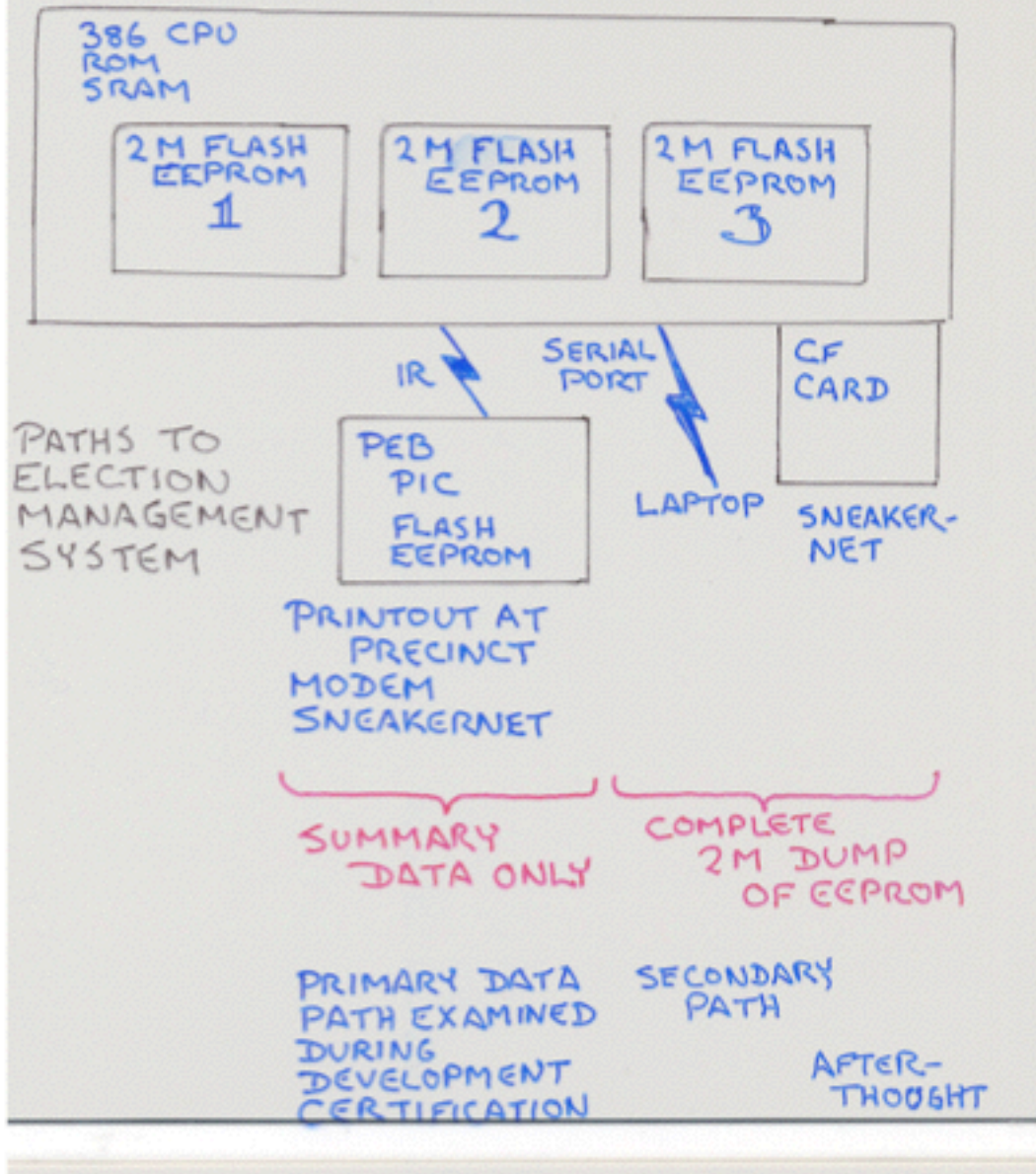
IS THIS SAFE ?

- YES, WITH RESERVATIONS

WHAT PROTECTIVE MEASURES ARE NEEDED

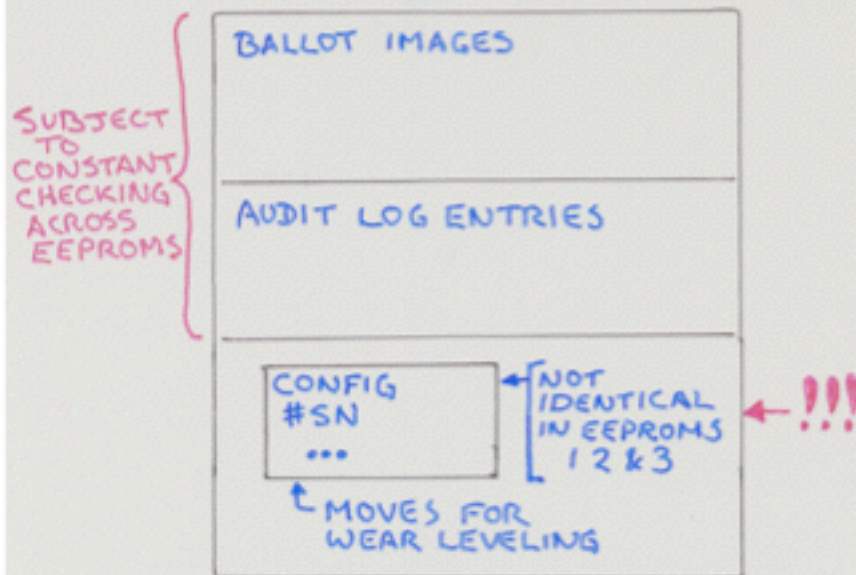
- LOTS

THE iVOTRONIC



Slide 10

2 M FLASH EEPROM CONTENTS



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 #SN READS WRONG

CORRECT #SN 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!