Lecture 35:
Electronic Voting
Announcements

• Homework 3B
• Project 3
Detection
Security Goals for an Election

• Integrity: no election fraud
• Transparency: Everyone – especially the loser – must be able to verify that the election was conducted appropriately
• Privacy: No one learns how the voter has voted
• Secret ballot: Voter cannot prove how she voted
Confusion at Palm Beach County polls
Some Al Gore supporters may have mistakenly voted for Pat Buchanan because of the ballot's design.

Although the Democrats are listed second in the column on the left, they are the third hole on the ballot.

Punching the second hole casts a vote for the Reform party.
From: Lana Hires
Subject: 2000 November Election

I need some answers! Our department is being audited by the County.

I have been waiting for someone to give me an explanation as to why Precinct 216 gave Al Gore a minus 16022 when it was uploaded. Will someone please explain this so that I have the information to give the auditor instead of standing here "looking dumb".
Summary Ballot Instructions

Press the candidate name or contest title to return to a contest.

Vote button will light up when you may cast your ballot.

Best Automobile Manufacturer
Vote For ONE

FORD

Best Vocal Artist
(Vote for Not More Than TWO)

Yes
No selection made.

Best Ice-Cream Flavor
Vote For ONE

No selection made.

Proposition 1
No selection made.

Proposition 2
No selection made.
Security Requirements for Electronic Voting Machines

• Machine must allow each authorized voter to vote exactly once; must prevent tampering with votes after they are cast.

• Machine should be verifiably trustworthy.

• Machine must randomize the order in which votes were cast.

• Machine must not give voter a “receipt”.
Early use of DREs

• Nov 4, 2002: State of Georgia votes on Diebold DREs.

• March 18, 2003: Diebold source code leaks.

Diebold’s Voter Authorization Protocol

QueryStatus  [Are you a valid card?]

ACTIVE (0x01)  [Yup.]

(record vote)

[Please cancel yourself.]

SetStatus CANCELED (0x08)

Status = CANCELED

Succeeded  [Ok.]

smartcard
Attack

QueryStatus [Are you a valid card?]  
ACTIVE (0x01) [Yup.]

(record vote)  
SetStatus CANCELED (0x08)  
Succeeded [Sure, whatever you say.]

[Are you a valid card?]  
ACTIVE (0x01) [Yup.  Still valid.  Nothing suspicious here.]

(record another vote)
Authenticating Election Officials

What's the secret PIN?
2301

What kind of card are you?
An administrator card.

What's the secret PIN?
2301

smartcard

Ok, you have admin access.
Machine error gives Bush 3,893 extra votes in Ohio

By John McCarthy, Associated Press

COLUMBUS, Ohio — An error with an electronic voting system gave President Bush 3,893 extra votes in suburban Columbus, elections officials said.

Franklin County’s unofficial results had Bush receiving 4,258 votes to Democrat John Kerry’s 260 votes in a precinct in Gahanna. Records show only 638 voters cast ballots in that precinct. Bush’s total should have been recorded as 365.
"I am committed to helping Ohio deliver its electoral votes to the president."

-- Wally O’Dell

CEO of Diebold
California Top-to-Bottom Review

• In 2007, California Secretary of State Debra Bowen commissions a review of California’s voting systems.

• 43 experts (led by David Wagner & Matt Bishop) examine voting systems used nationally.
Findings of the TTBR

- All voting systems were vulnerable to viral attacks: one outsider could subvert all voting machines countywide
Example Flaw: Diebold/Premier Systems

- **Bug:** The code that reads data off the memory card has buffer overrun vulnerabilities.
- **Attack:**
  - Attacker writes malicious code onto a memory card
  - When central PC reads votes off card on election night, it gets infected
  - Infected PC writes malicious code onto all cards used in the next election, infecting entire county
Result of TTBR

• Bowen decertifies most touchscreen e-voting machines and imposes strict new procedural protections.

• Most Californians now vote on paper ballots.
Backdoors and the Insider Threat

Ronald Dale Harris
Employee, Gaming Control Board, 1983-1995
Arrested, Jan 15, 1995
Convicted, Sept 23, 1997, for rigging slot machines
Attempted Back Door in Linux Kernel

... schedule(); goto repeat;
}
if ((options == (__WCLONE|__WALL)) && (current->uid == 0))
    retval = -EINVAL;
retval = -ECHILD;
end_wait4:
current->state = TASK_RUNNING;
...
Defense Against Backdoors in Voting Machines

• Malicious logic hidden by an insider might, e.g., record votes incorrectly to favor one candidate. How would we defend a voting system against this kind of insider threat?

• Potential solutions:
  • Verify that the software is free of Trojans and will work correctly on all future elections. (beyond the state of the art)
  • Assume software might contain Trojans. Verify that software worked correctly in this particular election. (voter-verified paper records + random audits)
Statistical Audit

• After election, randomly choose 1% of machines and manually recount the paper records on those machines. If paper count ≠ electronic count, there was fraud.
• If » 100 machines lie, detection is likely. Consequently: If paper count = electronic count, then likely no more than ~100 machines lied.

The tallies are $t_1, \ldots, t_n$

Prover (Elec. Official)  
Verifier (skeptical voter)  
Show me the paper for machine $i$.  
(voter-verified paper audit trail)
Conclusions: Electronic voting

- E-voting security is hard, but can be made secure and trustworthy, if it can be audited.
Broader Takeaways

• Sometimes technical threats can be handled through non-technical defenses.
• Seek independent, end-to-end checks that the system is working properly.
• Securing systems against malicious insiders is extremely challenging.
• Business structure determines the technology that is built & deployed. If buyers cannot measure how secure a product is, be prepared for market failures.
Extra Material
THE HAZARDS OF ONLINE VOTING...

George W. Bush R
John F. Kerry D
Ralph Nader I
Low-Cost Home Mortgage
Generic Viagra
Enlarge Your Thingy

Greetings! I am Ndugu Scamu, ex-interior minister of Nigeria, and I need your help to transfer $150,000,000 in funds to a bank.