CSE 484 / CSE M 584: Computer Security and Privacy

Fall 2021

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Announcements

- Things Due:
  - Homework #1: Due next Friday (10/8)

- Questions from last time:
  - Groups can span CSE 484 and CSE M 584
  - In-class assignments can be done up until the start of the next class (e.g., if you are in different time zone, participating remotely and watching Zoom recording)
- Any logistics questions at this point?

584 Reminder

- Research readings are due starting *next* Friday (Oct 8)

- 484: You can do them as extra credits

THREAT MODELING

Threat Modeling (Security Reviews)

- Assets: What are we trying to protect? How valuable are those assets?
- Adversaries: Who might try to attack, and why?
- Vulnerabilities: How might the system be weak?
- Threats: What actions might an adversary take to exploit vulnerabilities?
- Risk: How important are assets? How likely is exploit?
- Possible Defenses
- Not "traditional" threat modeling, but important (both in general, and to help better understand the system prior to threat modeling):
  - Benefits: Who might the system benefit, and how?
  - Harms: Who might the system harm, and how?

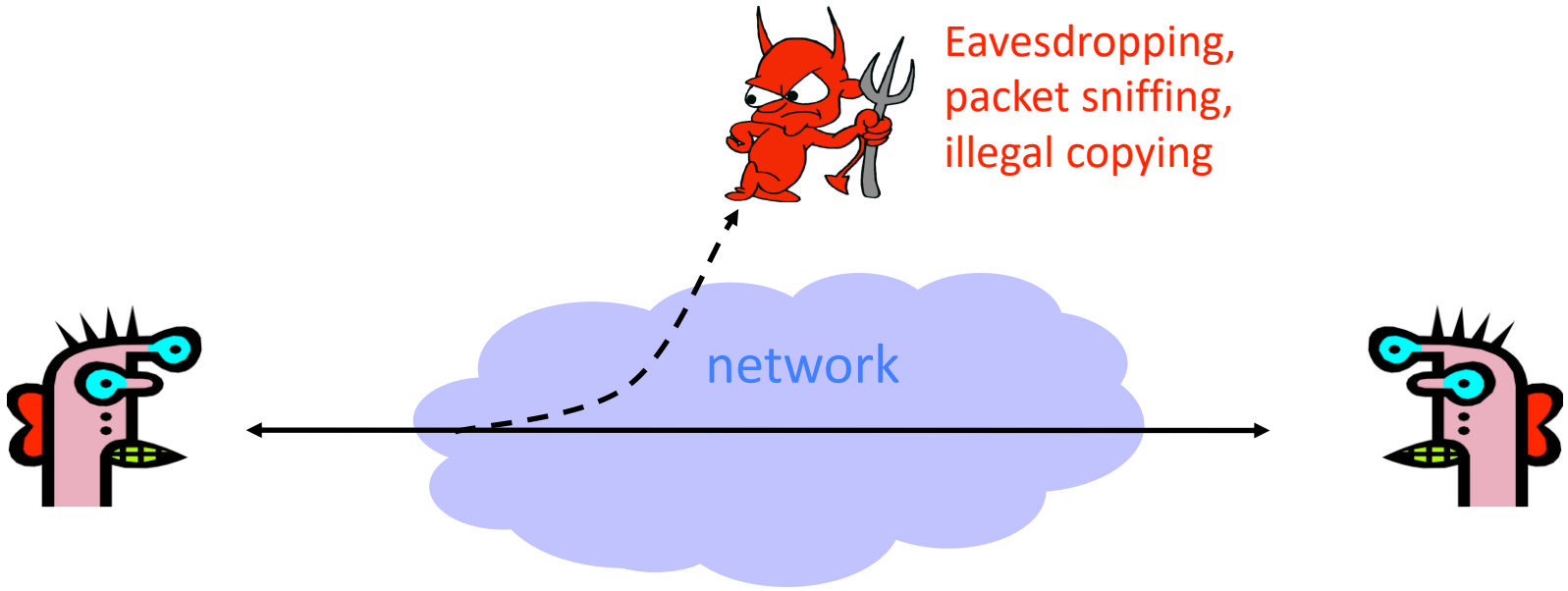
What's *Security*, Anyway?

- Common general security goals: "CIA"
  - Confidentiality
  - Integrity
  - Availability

- Or the extension: CPIAAU (Parkerian Hexad)
  - Control
  - Authenticity
  - Utility

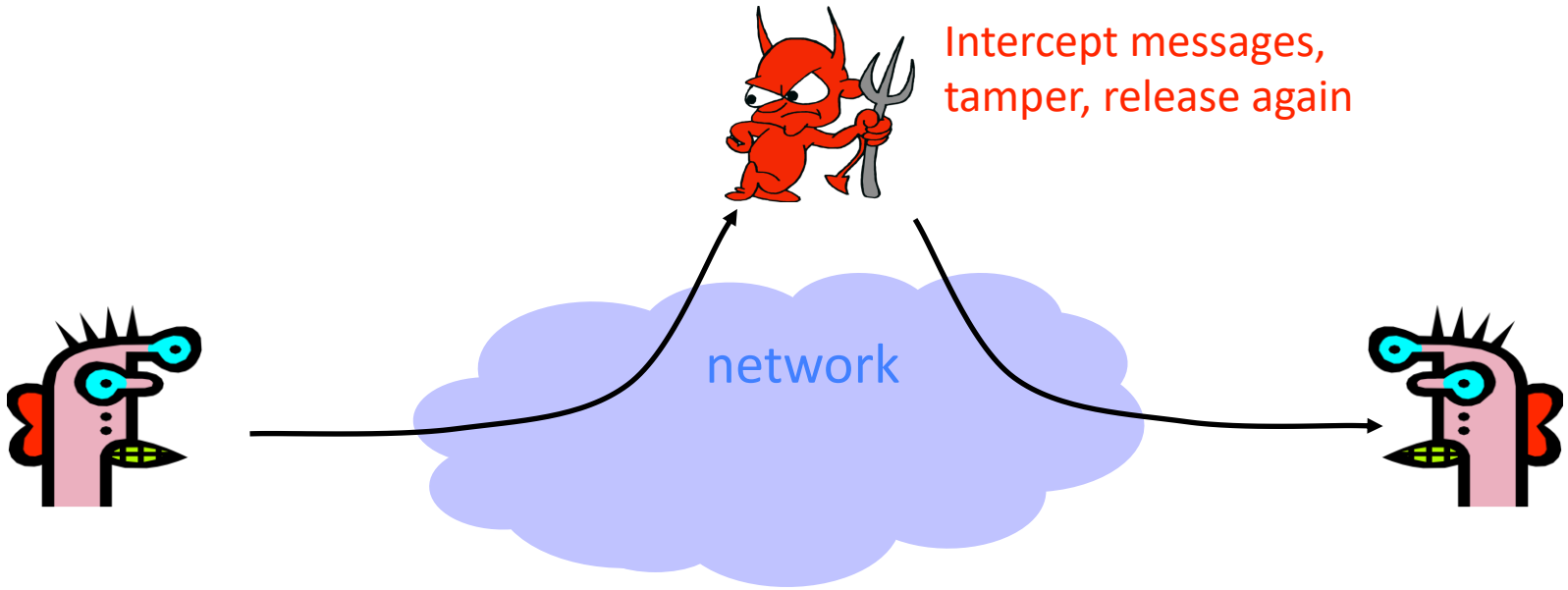
Confidentiality (Privacy)

- Confidentiality is concealment of information.



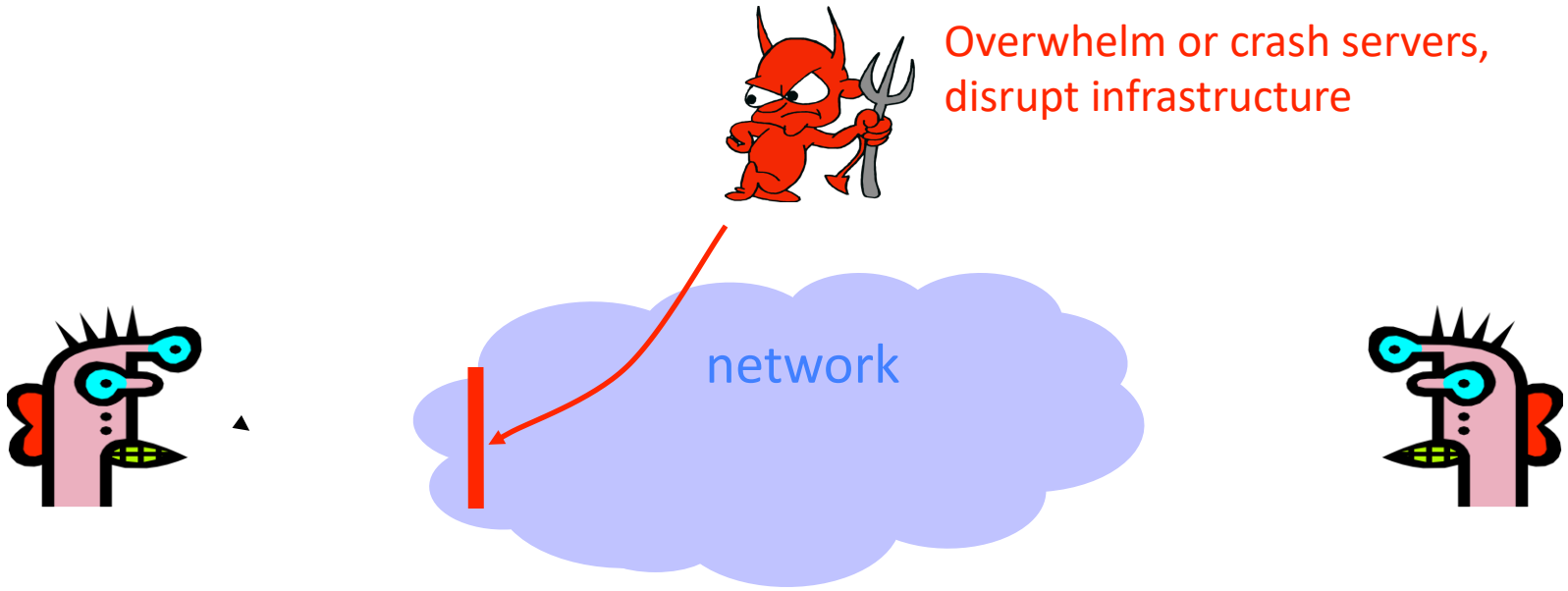
Integrity

- Integrity is prevention of unauthorized changes.



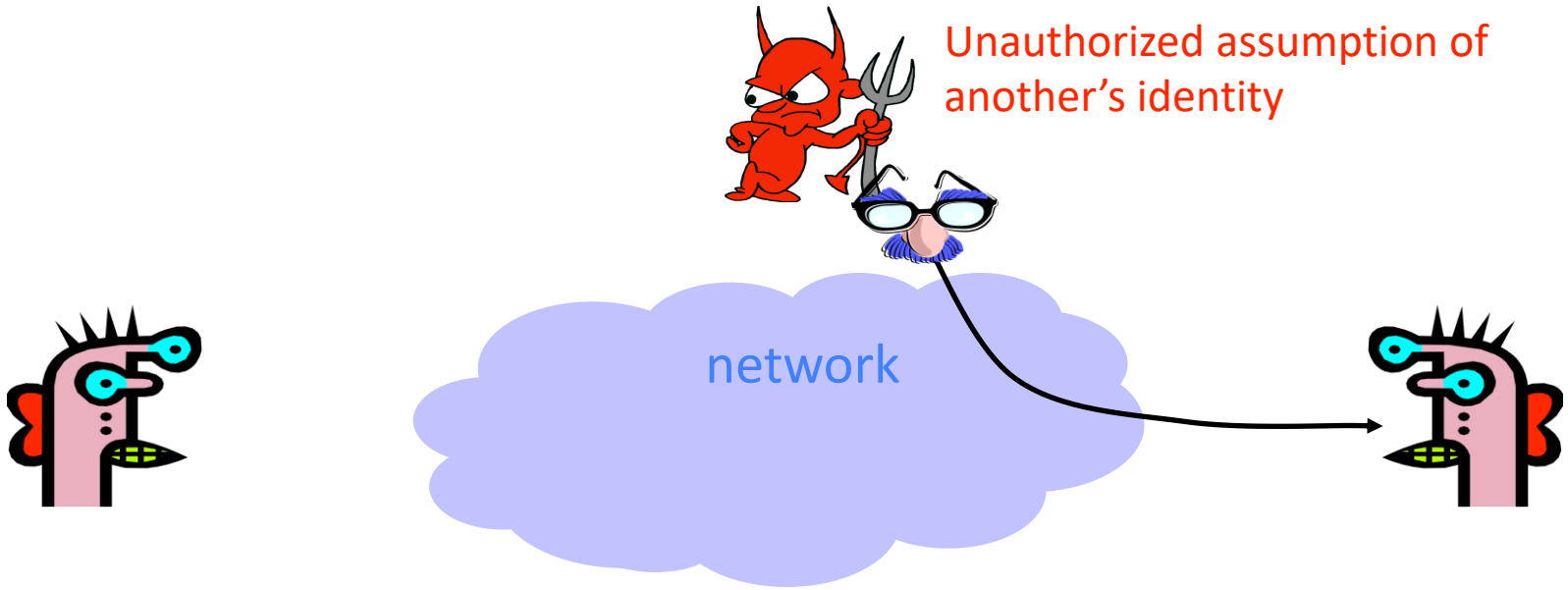
Availability

- Availability is ability to use information or resources.



Authenticity

- Authenticity is knowing who you're talking to.

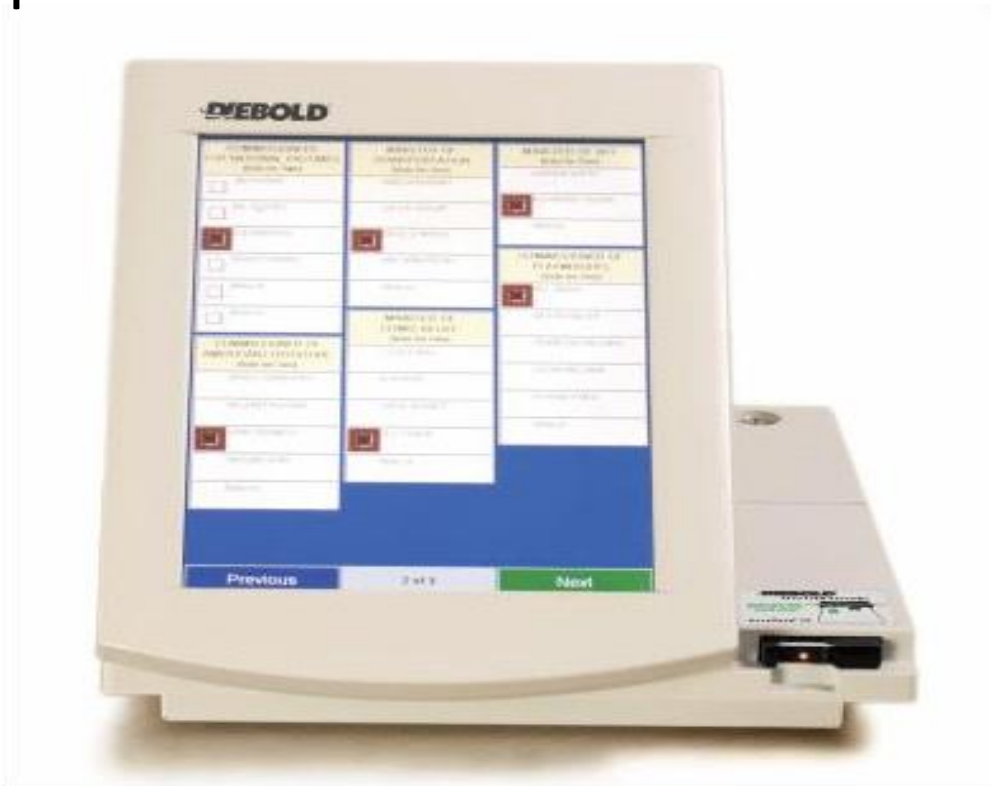


Threat Modeling

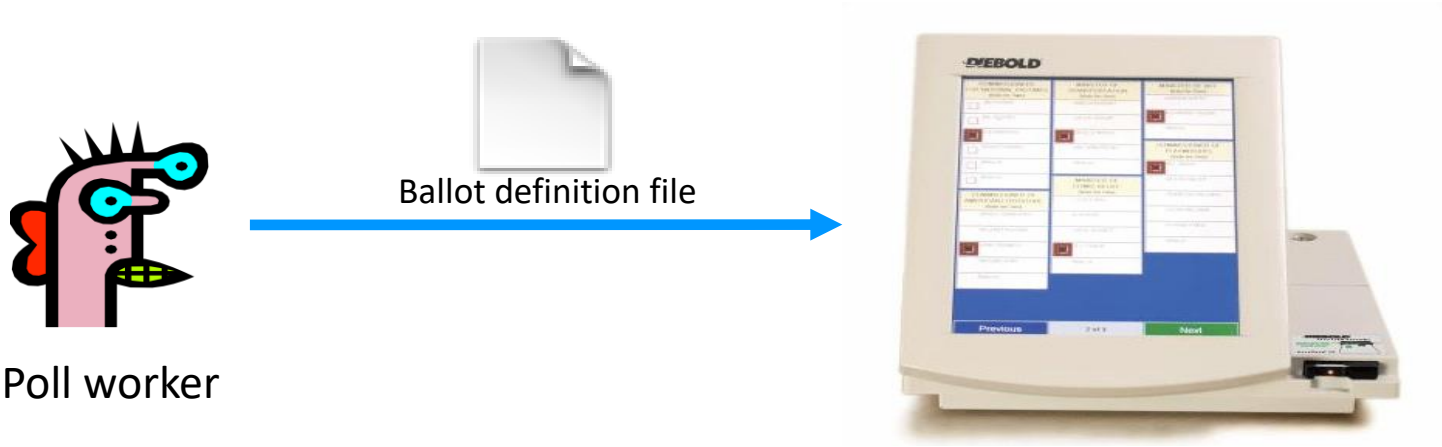
- There's no such thing as perfect security
  - But, attackers have limited resources
  - **Make them pay unacceptable costs / take on unacceptable risks to succeed!**
- Defining security per context: identify assets, adversaries, motivations, threats, vulnerabilities, risk, possible defenses

Threat Modeling Example: Electronic Voting

- Popular replacement to traditional paper ballots

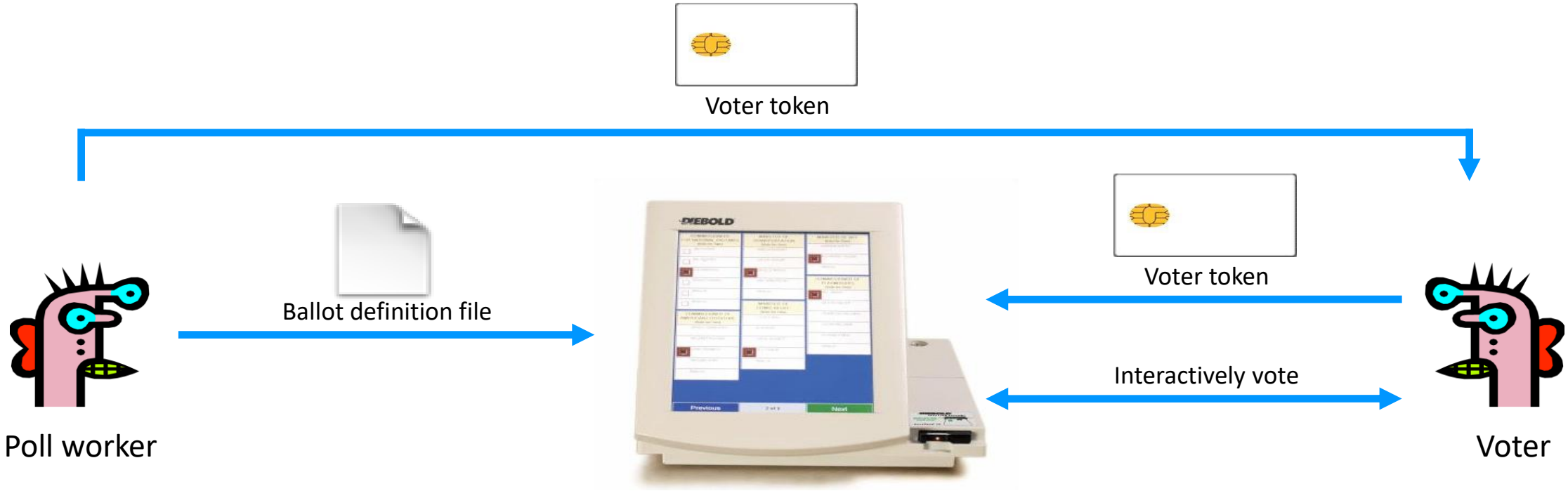


Pre-Election



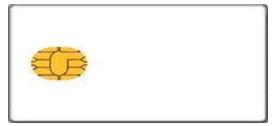
Pre-election: Poll workers load "ballot definition files" on voting machine.

Active Voting



Active voting: Voters obtain single-use tokens from poll workers. Voters use tokens to activate machines and vote.

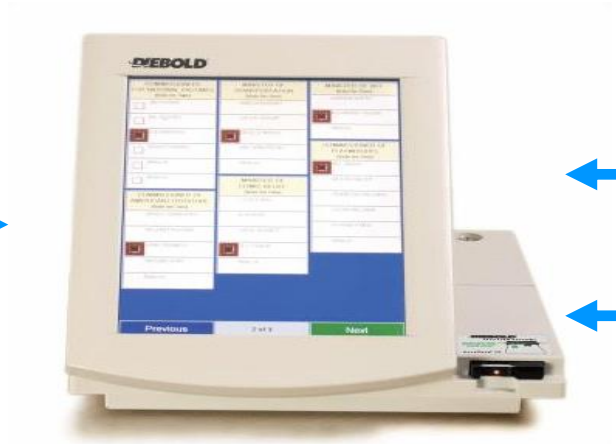
Active Voting



Voter token

Ballot definition file

Poll worker



Voter token

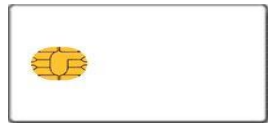
Interactively vote

Voter

Encrypted votes

Active voting: Votes encrypted and stored.
Voter token canceled.

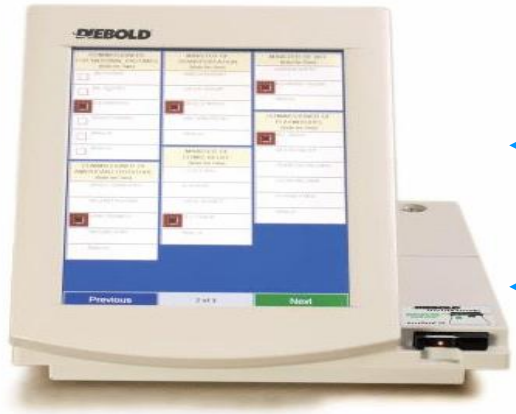
Post-Election



Voter token

Ballot definition file

Poll worker



Voter token

Voter

Interactively vote

Encrypted votes

Recorded votes

Tabulator

Post-election: Stored votes transported to tabulation center.

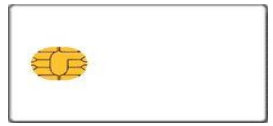
In-Class “Worksheet” Experiment

- Go to Canvas -> Quizzes -> “In-Class Activity – March 31”
- Fill out the questions while discussing with your breakout group
  - Everyone should submit their own
  - **No need for polish or complete sentences** – jot things down as you would on a piece of paper while chatting in class

Security and E-Voting (Simplified)

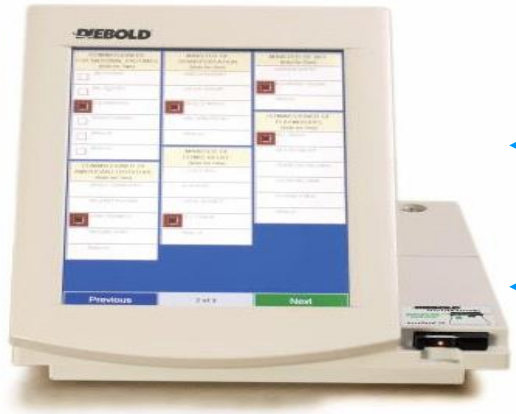
- Functionality goals:
  - Easy to use, reduce mistakes/confusion, make voting more accessible
- Security goals:

Can You Spot Any Potential Issues?



Voter token

Ballot definition file



Voter token

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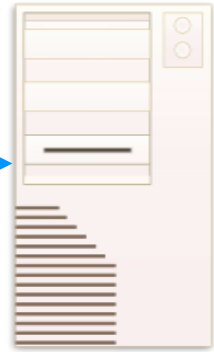


Tabulator

Q1: Security goals? Assets?
Q2: Adversaries? Attack goals?


provent cheat
protect ballots
voter confidence
who they are voting for
toekns
identity concealment
single voting
one token per voter
vote
voter
voter privacy
authentication
voter's information
reduce voter fraud
voter information
validity of votes
Fairness
accuracy
integrity of the votes
protect voter identity
privacy
vote count
protect vote
fair election
votes
voting machine
results
tokens
availability
confidentiality
election integrity
anonymity
authenticity
integrity
only vote once
accurate votes
integrity of vote count
Voter token
token forgery
voter identity
availability of voting
integrity of votes
voter authenticity
no changing of cast votes
no repeated vote
one person one vote
confidentiality of votes
the data for voters might
personal informations


intercept votes to change
prevent people voting
foreign governments
organized crime
foreign countries
troublemakers
political groups
voter fraud
politicians
undermine legitimacy
sway votes
Russia
opposite party
voter token authenticity
foreign states
trump supporters
trolls
hackers
change vote
candidates
Foreign nations
political parties
corporations
Lobbyists
political party
parties
change outcome
physical security
poll worker
nation stateterrorists
Poll workers
other countries
rigged election
change votes
political affiliate party
Foreign government
change election outcome

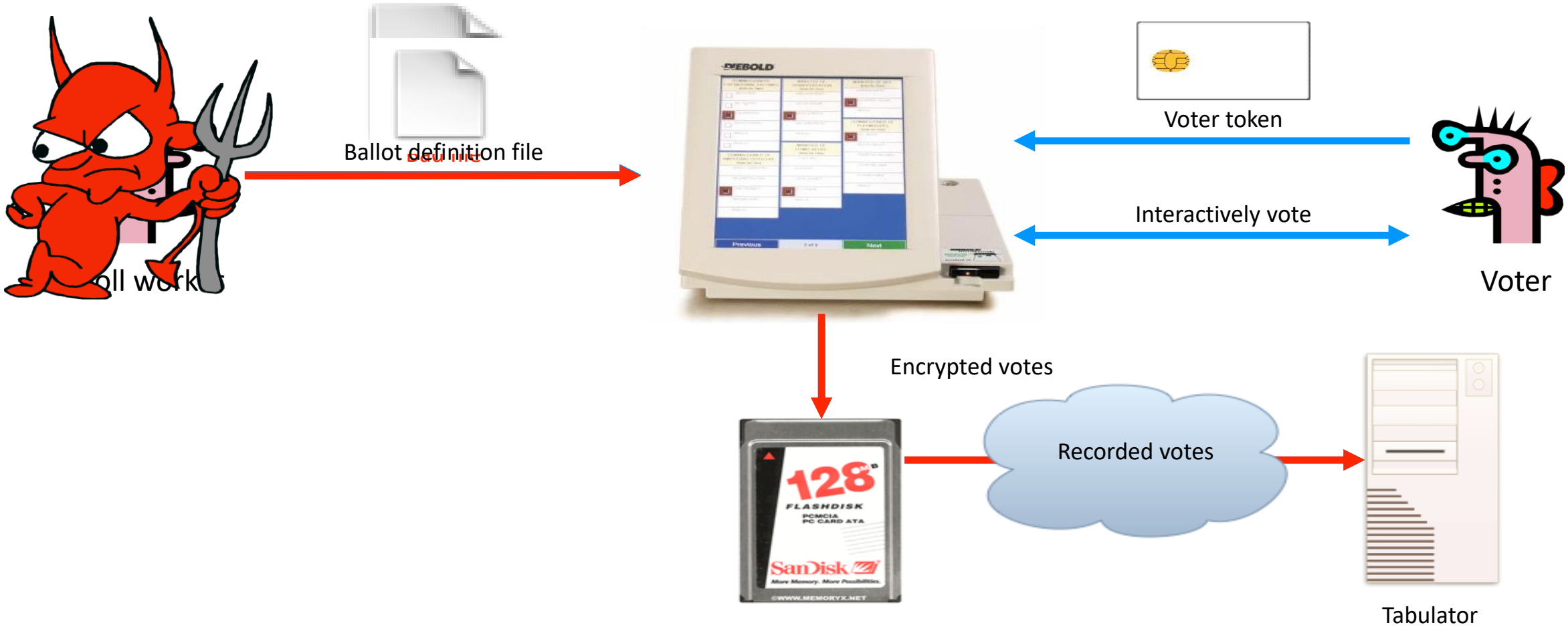
What Software is Running?

Problem: An adversary (e.g., a poll worker, software developer, or company representative) able to control the software or the underlying hardware could do whatever they wanted.


KEYS TO THE KINGDOM
Photo taken from Diebold's online store. The keys that open every Diebold touch-screen voting machine. Working copies have been made from the photo.

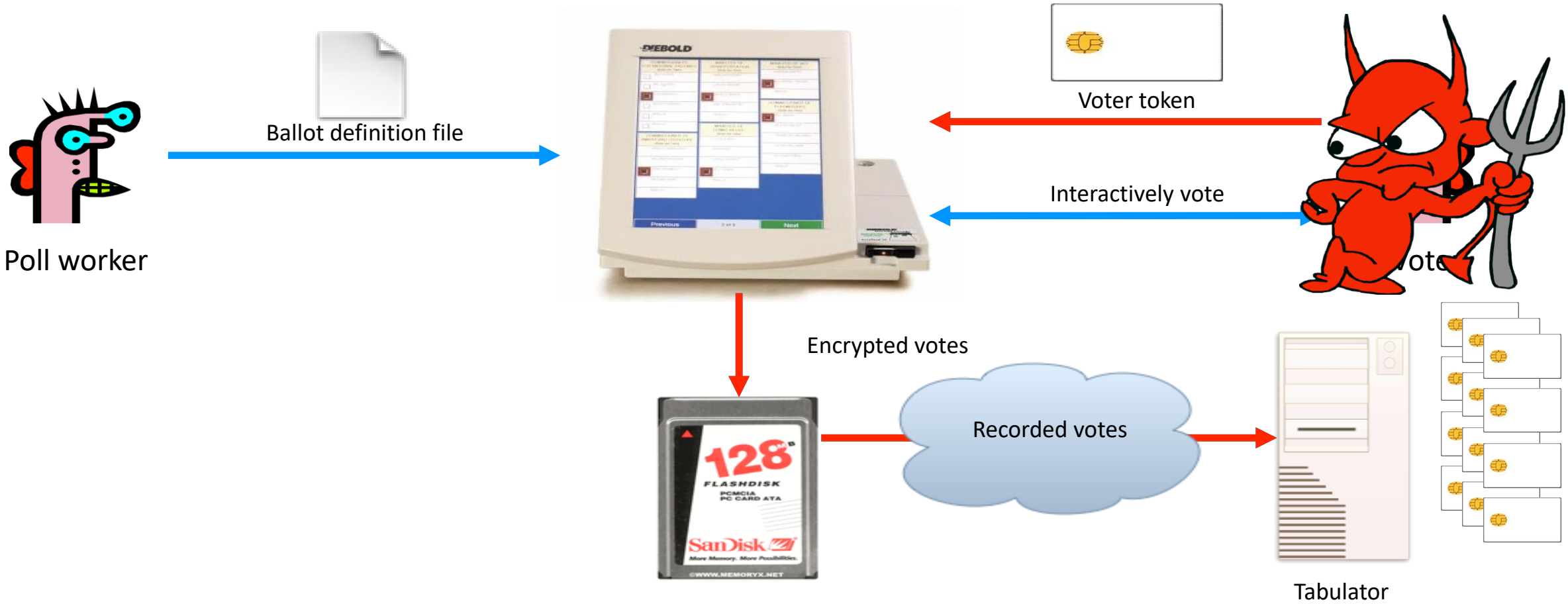
Problem: Ballot definition files are not authenticated.

Example attack: A malicious poll worker could modify ballot definition files so that votes cast for "Mickey Mouse" are recorded for "Donald Duck."



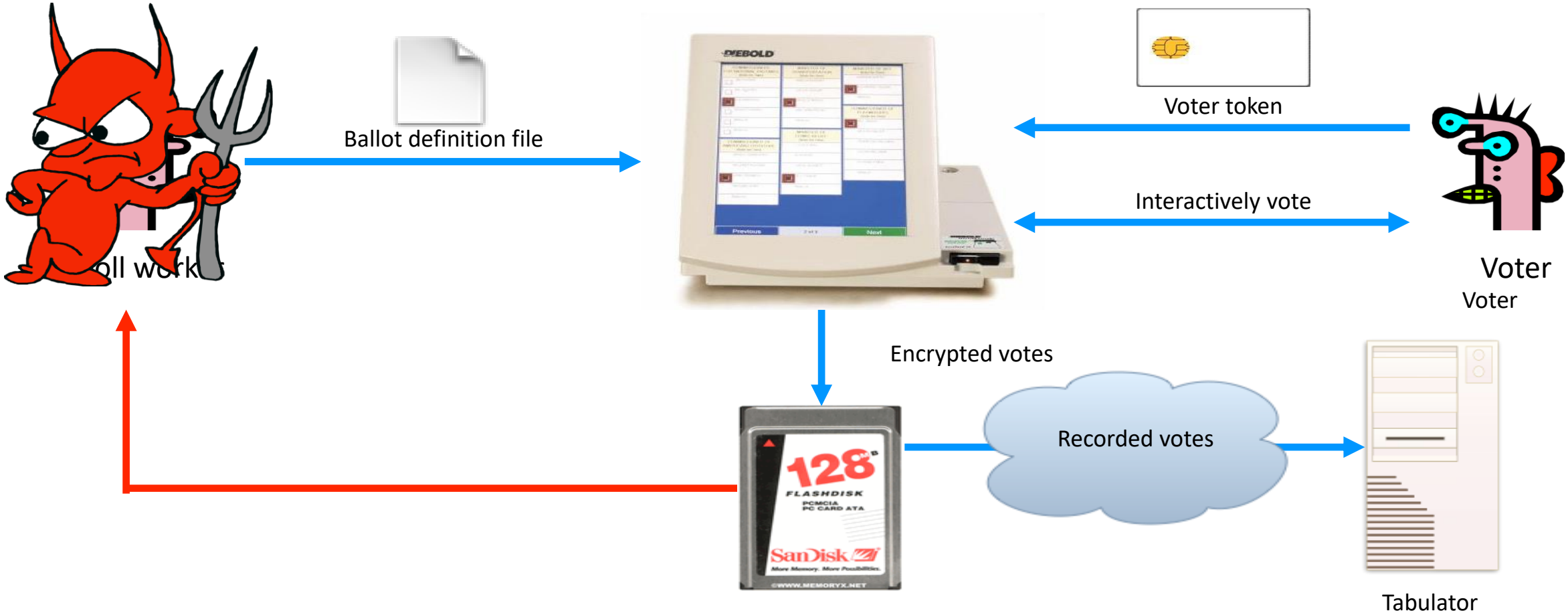
Problem: Smartcards can perform cryptographic operations. But there is no authentication from voter token to terminal.

Example attack: A regular voter could make their own voter token and vote multiple times.



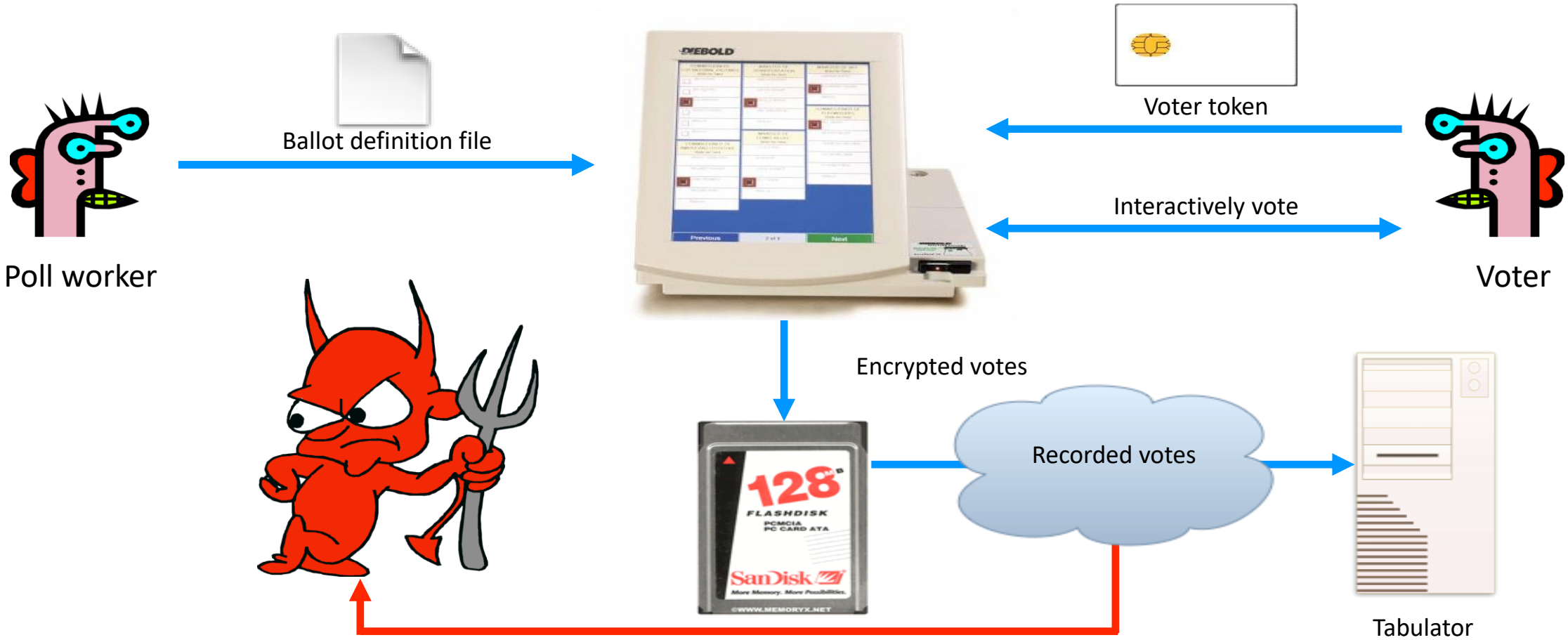
Problem: Encryption key ("F2654hD4") hard-coded into the software since (at least) 1998. Votes stored in the order cast.

Example attack: A poll worker could determine how voters vote.



Problem: When votes transmitted to tabulator over the Internet or a dialup connection, they are decrypted first; the cleartext results are sent the the tabulator.

Example attack: A sophisticated outsider could determine how voters vote.



TOWARDS DEFENSES

Approaches to Security

- Prevention
  - Stop an attack
- Detection
  - Detect an ongoing or past attack
- Response and Resilience
  - Respond to / recover from attacks

- The threat of a response may be enough to deter some attackers

Whole System is Critical

- Securing a system involves a whole-system view
  - Cryptography
  - Implementation
  - People
  - Physical security
  - Everything in between

- This is because "security is only as strong as the weakest link," and security can fail in many places
  - No reason to attack the strongest part of a system if you can walk right around it.

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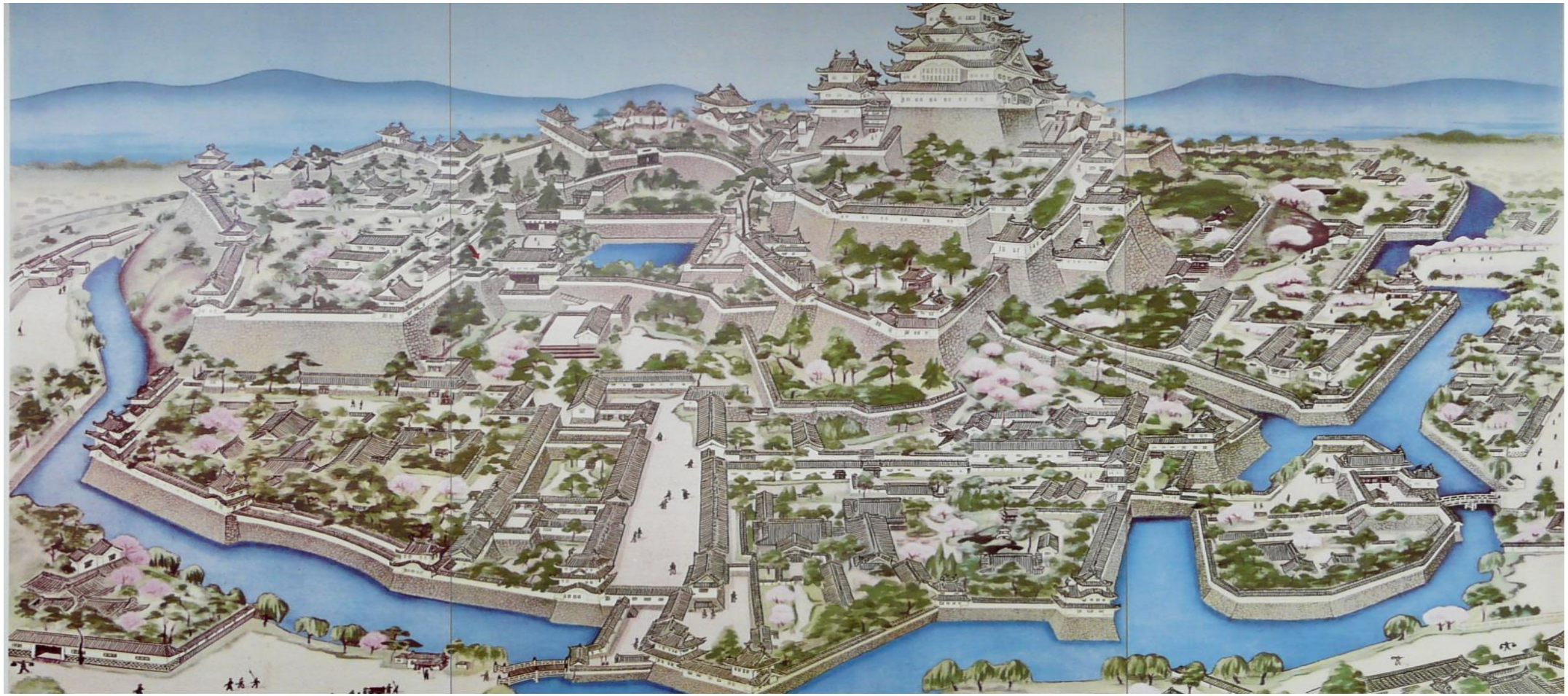
Attacker's Asymmetric Advantage



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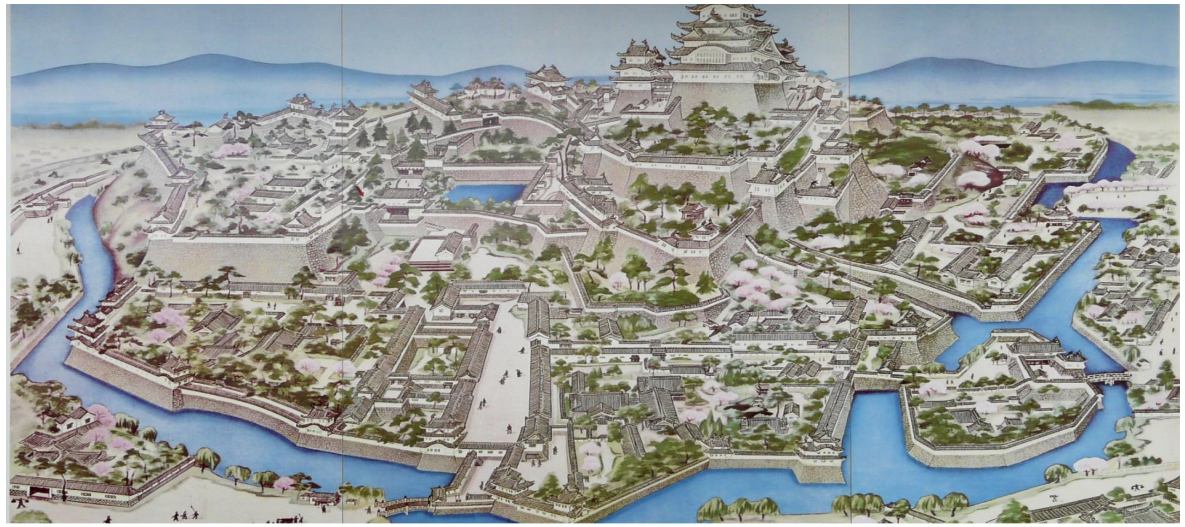

- Attacker only needs to win in one place
- Defender's response: Defense in depth

From Policy to Implementation

- After you've figured out what security means to your application, there are still challenges:
  - Requirements bugs and oversights
    - Incorrect or problematic goals
  - Design bugs and oversights
    - Poor use of cryptography
    - Poor sources of randomness
    - …
  - Implementation bugs and oversights
    - Buffer overflow attacks
    - …
  - Is the system **usable**?

Many Participants

- Many parties involved
  - System developers
  - Companies deploying the system
  - The end users
  - The adversaries (possibly one of the above)
- Different parties have different goals
  - System developers and companies may wish to optimize cost
  - End users may desire security, privacy, and usability
    - Side question: Do system developers / companies really understand the needs and values of all their users? Or all stakeholders who might be impacted by the system?
  - But the relationship between these goals is quite complex (e.g., will customers choose features or security?)

Better News

- There are a lot of defense mechanisms
  - We'll study some, but by no means all, in this course
- It's important to understand their limitations
  - "If you think cryptography will solve your problem, then you don't understand cryptography… and you don't understand your problem" -- Bruce Schneier