Applied Cryptography Enabling Trustworthy Electronic Voting

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Disclosure Note

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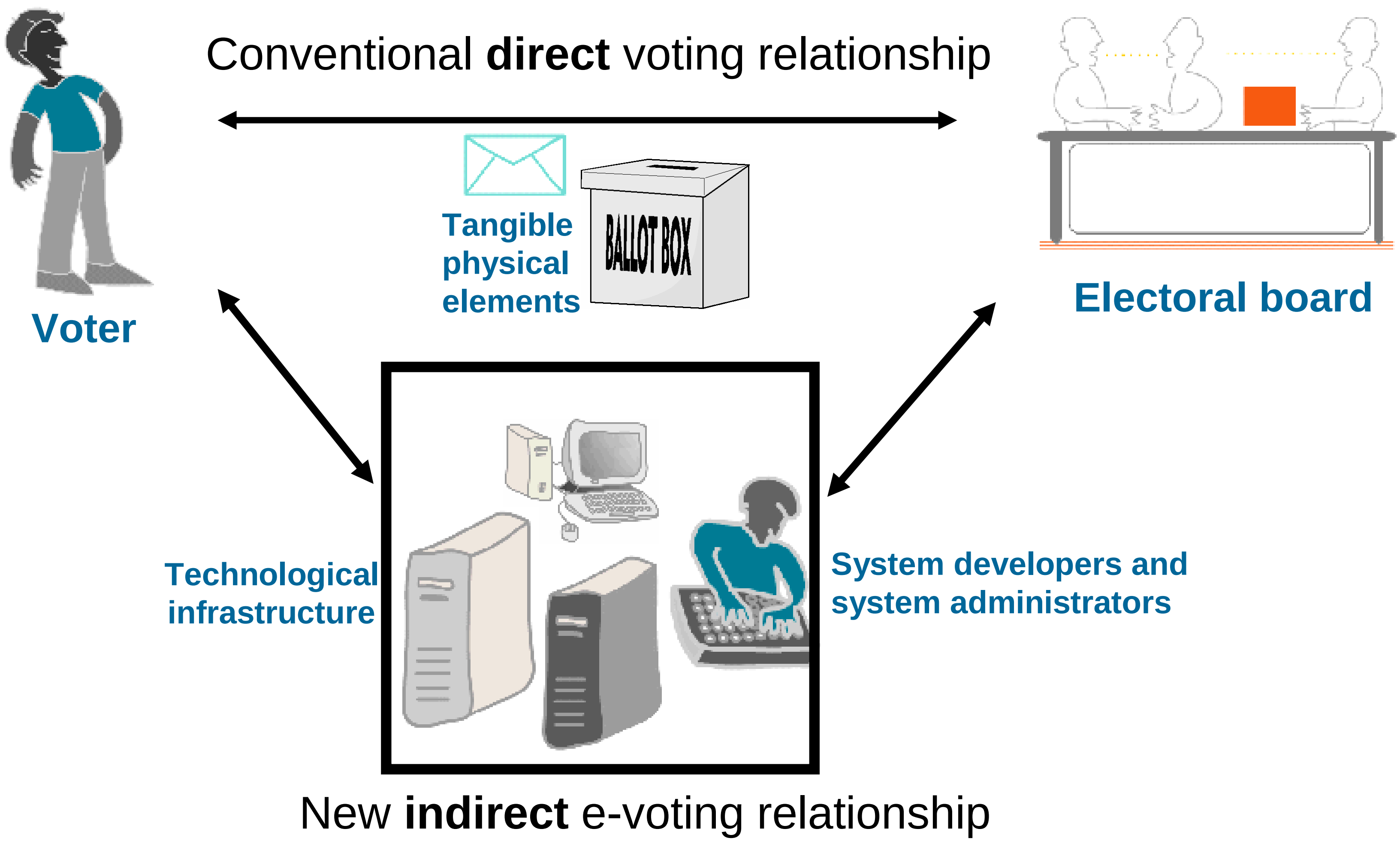
Change of Voting Paradigm



Electronic voting creates a new indirect voting relationship that brings **new security risks** that reduce the trustworthiness of the electoral process.

Sources of New Security Risks

Four main **sources of security risks** emerge due to the technical infrastructure interposed between the voter and the electoral board:

- The **digital (virtual) nature** of the ballots
  - Ballots may be added, deleted or otherwise manipulated
  - Voters' privacy may be compromised on a large scale
- The **complexity** of the systems used
  - Electronic equipment may malfunction
  - Software may contain programming errors
- The **lack of transparency** of the systems used
  - The technical infrastructure is not easily audited
- The introduction of **people with privileges** on the systems used
  - New players enter the scene

These risks all serve to undermine the trust in the e-voting system caused by an indirect e-voting relationship

How to Manage These New Risks

?

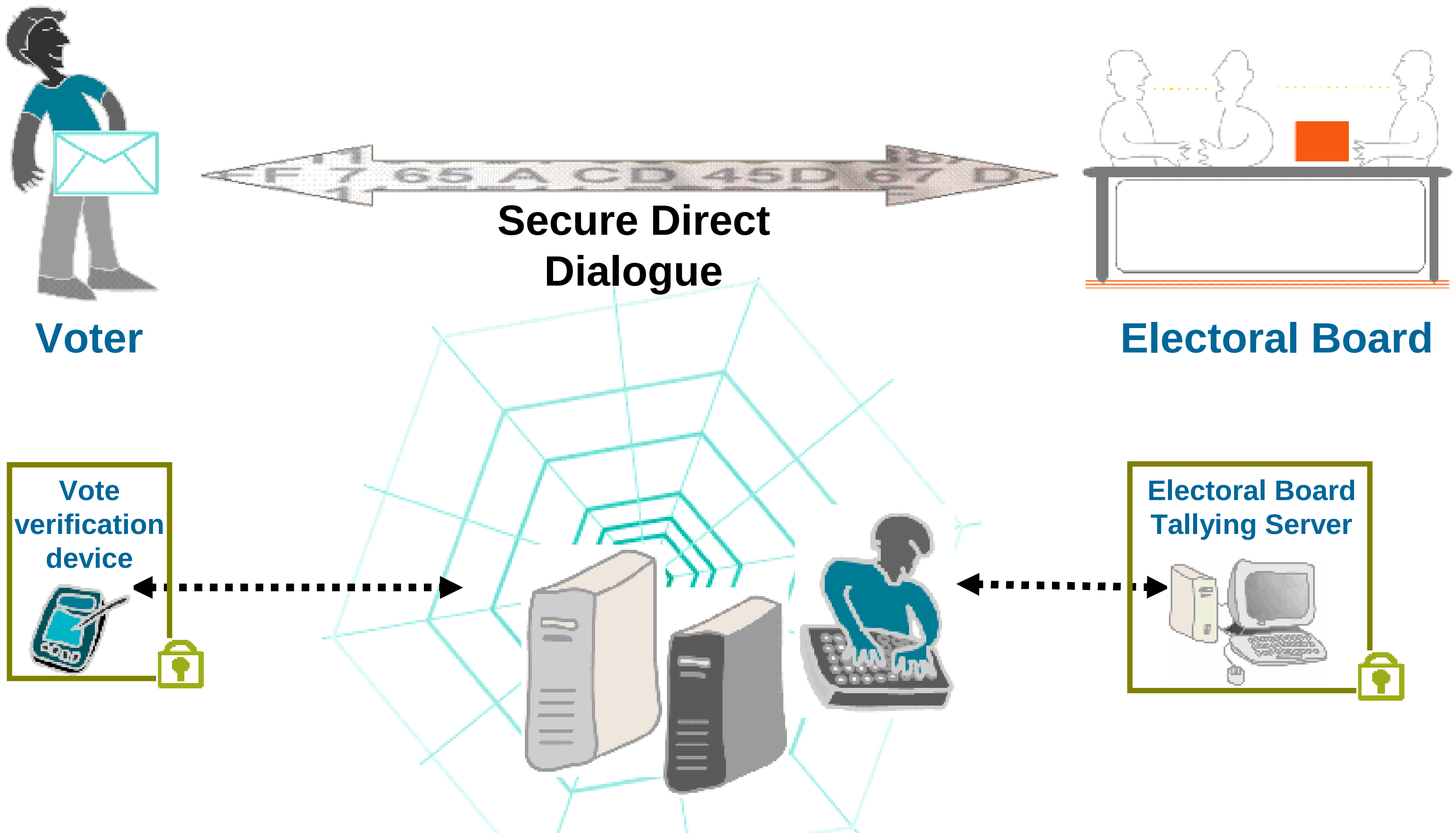
Ignore the risks → Expect **catastrophic** results

Manage the risks by deploying an adequate security architecture → Use a combination of **technological, physical and procedural security measures** to re-establish the direct dialogue between voter and electoral board

Avoid the risks by returning to the tangible election → Create a **physical audit trail** to bring trust to the voting process

We believe that adequate solutions can be devised to **bring trust to electronic voting** systems

Security Architecture Overview



A **secure direct dialogue** between the voter and the electoral board is created by tunnelling through the complex technological infrastructure

Security Architecture Principles

- Critical functions should be isolated on **simple modules** that are **physically protected**
  - Avoid complexity on these key modules so that they are easier to secure
- **Source code** on the simple modules should be **made available for inspection and certification**
  - Closed voting systems located between these modules do not need to be trusted for the whole system to be trustworthy
    - e.g. SSL connection tunnelling through insecure internet
- **Extensive auditing** must be done of the system design, the modules and the software
  - To trust an open security system that surrounds a closed voting system, the security system must be beyond reproach
- **Voter-verification** is key
  - For security, and more importantly for trust in the system
  - Run independently of the voting system

Security Architecture Modules

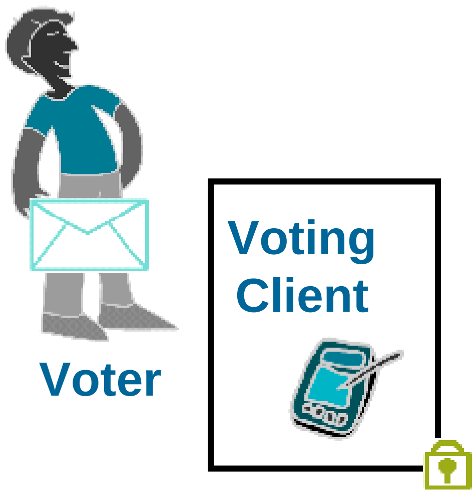
- **Voter verification device**
  - A simple *hardware security module* connected to the DRE
  - Includes either a printer or a visual display for verification purposes
  - Contains buttons to either confirm or reject the vote as presented
  - Runs digitally signed certified software that performs the voter-side of the cryptographic protocol

- **Electoral board tallying server**
  - A special-purpose stand-alone server that is physically monitored
  - Runs digitally signed certified software that performs the electoral board-side of the cryptographic protocol

The security modules are simple, comprehensively audited, and physically protected

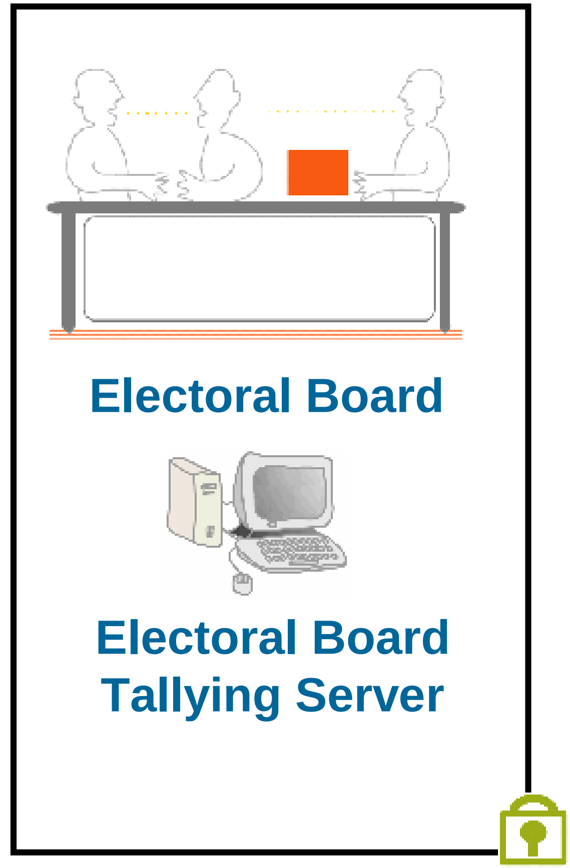
Voter Verification Device Tasks

- Asks the voter for confirmation of their vote
  - The voter-verification takes place outside of the DRE
- Protects the ballot's integrity & confidentiality with a digital envelope
  - The private key needed to open the envelope does not exist during the election
- Attaches a proof of authenticity to the ballot envelope
- Keeps a fingerprint/copy of the ballot box
- Can provide cryptographic security for paper ballots that are printed



Electoral Board Tallying Server Tasks

- Generates the unique cryptographic key pair
  - This key pair is used to lock (with the public key) and unlock (with the private key) ballots into digital envelopes
- Distributes trust among the members of the electoral board
  - A secret sharing scheme allows the electoral board to act collectively
- Uses a mixing protocol to break any correlation between clear ballots and enveloped ballots
  - This allows the system to ensure the anonymity of the vote



Security Architecture Benefits

- The **critical security requirements** for e-voting systems are resolved by transferring the control of all critical functions to the electoral authorities:
  - **Voter self-verification** during the voting process
  - Preserves **anonymity**
  - The **protection** of the digital urn:
    - Partial results stay secret during the election
    - Integrity of votes is guaranteed
    - Addition of bogus votes is not possible
- Using **simple secure modules** for critical functions avoids the need to place trust in complex technology that may be harder to secure
- The **replication of conventional protection mechanisms** online will foster a greater acceptation of e-voting by all parties involved
  - e.g. the use of an electoral board
- The architecture is **voting-channel neutral**
  - This can be used on DREs in polling stations or via internet remotely

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