Usability of End-to-End Verifiable E-Voting Schemes

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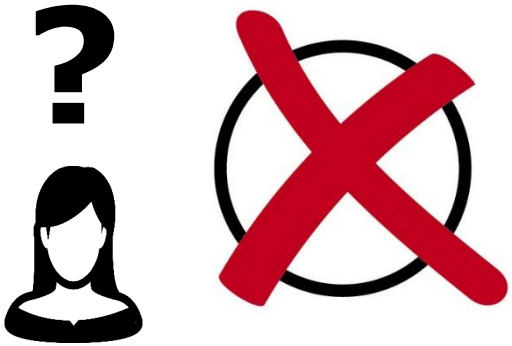
SECUSO
SECURITY · USABILITY · SOCIETY

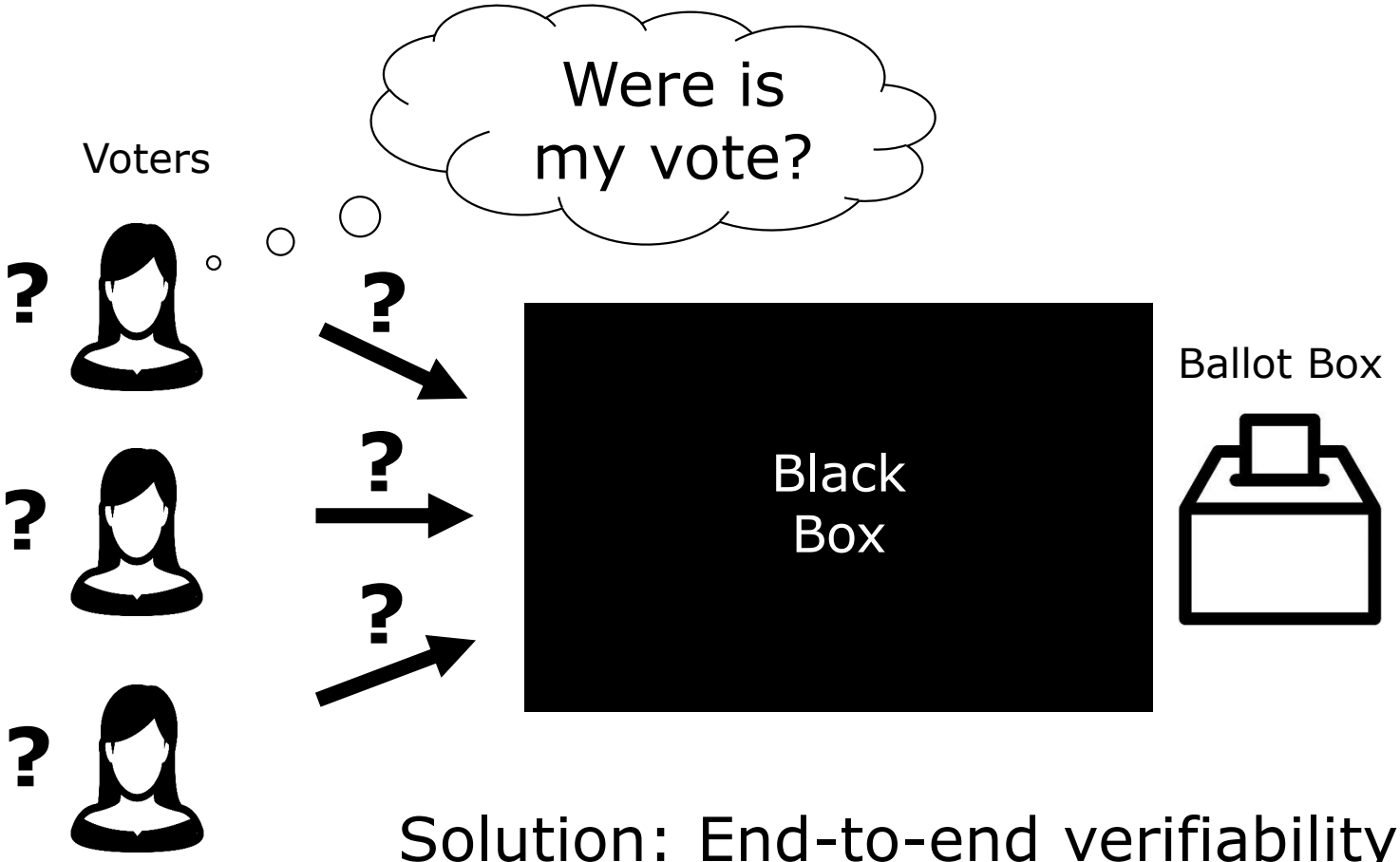
CRISP
Center for Research in Security and Privacy



SECUSO

- Security, Usability und Society
- Research group at TU Darmstadt
- Human Centered Security
- Interdisciplinary team

Motivation



Solution: End-to-end verifiability

End-to-end Verifiability

- Cast-as-intended

  Cast vote corresponds to the voter‘s intent

- Recorded-as-cast

  Recorded vote matches the cast vote

- Tallied-as-recorded

  All recorded votes are correctly included in the result

Cast-as-intended Verifiability (C-a-I)

- „Decryption“
  - E.g. Estonian system
- Challenge or cast
  - E.g. Benaloh Challenge
- Return Codes
  - E.g. Pretty Good Privacy
- Tracking Codes
  - E.g. Selene

Impact of Usability

- Attacker alters vote in secret
- Voting platform alters vote in secret
- Voting platform might malfunction

- Bad usability of C-a-I leads to
  - More successful attacks
  - Inaccurate election results

Usability (ISO 9241-11)

- Effectiveness

  Ability of users to complete their task.

- Efficiency

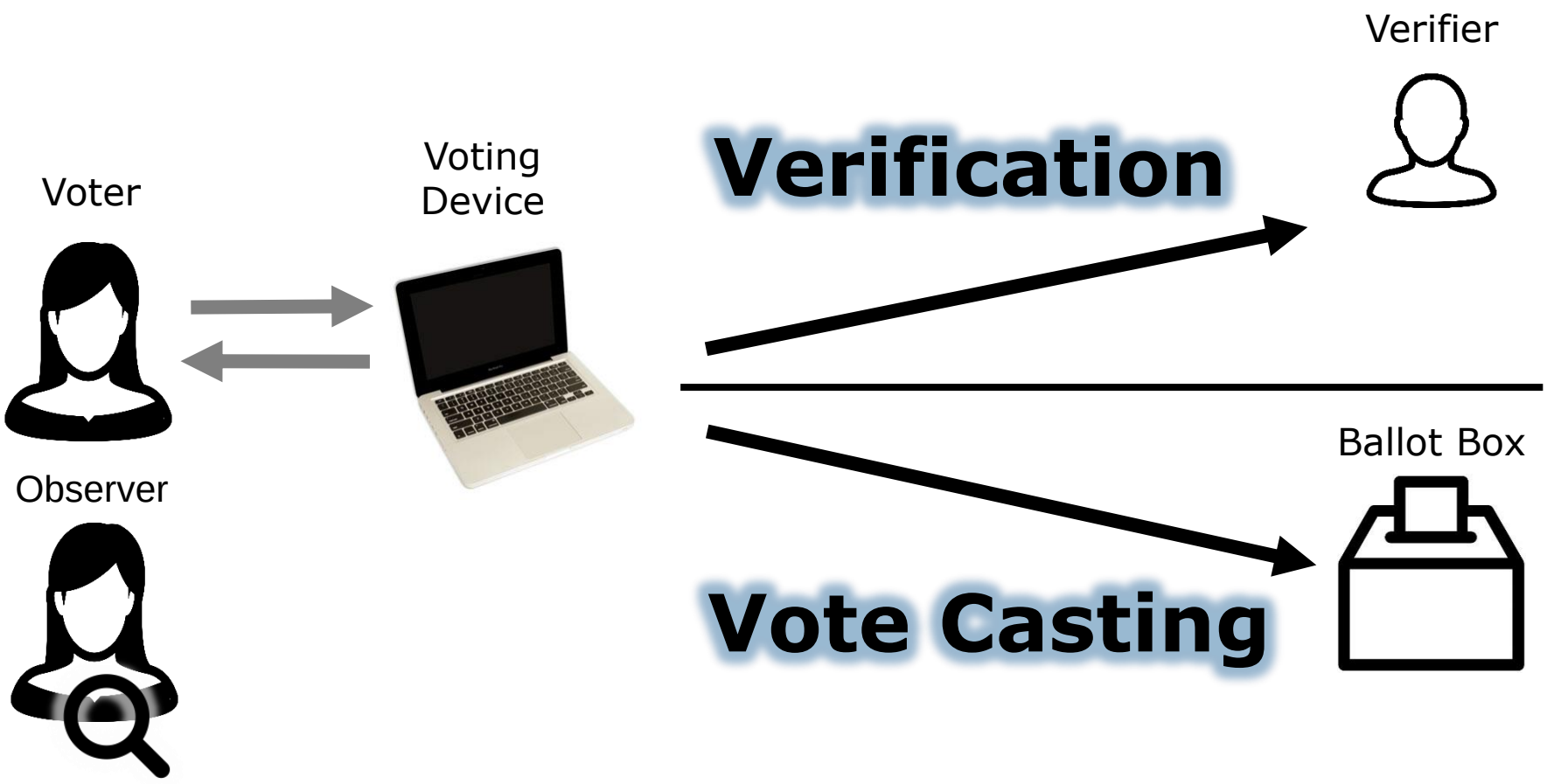
  Extent to which users consume resources to perform their task.

- Satisfaction

  Level of satisfaction users experience in performing their task.

Benaloh Challenge
User Study

Benaloh Challenge



3 Approaches

- Differences in the transfer of verification data
- Differences in the degree of voter involvement

Manual (Copy and Paste)

Automatic

Mobile (Scan of QR code)

Study Scenario

- German Federal Election 2017

3 Voting Websites

- Verifier
  - BSI
  - OSCE

Demo-Session
After workshop

- Verification devices
  - Android App

Study Design

- Lab study: 95 participants
- Between subjects
- Lab devices
- First-time voters: 17-22 years old

Procedure

- Explanation of the study
- Declaration of consent

Procedure

- Demographic questions:
  - Age
  - Gender
  - Occupation
  - Voting experience

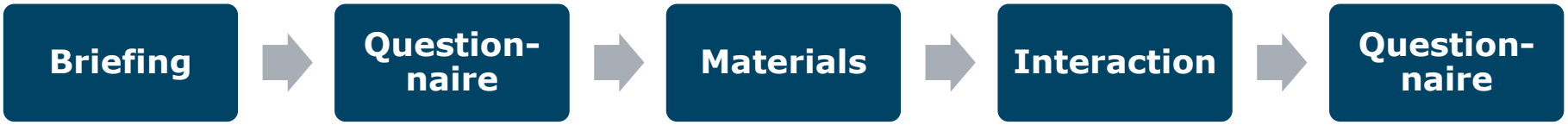
Procedure

- Internet voting document incl. login data
- Instructions
  - Mark party „SPD“
  - Verify vote using website / app
  - Mark party „GRÜNE“
  - Cast vote

Procedure

- Screenrecording of devices
- Logging of time by software
- Observation

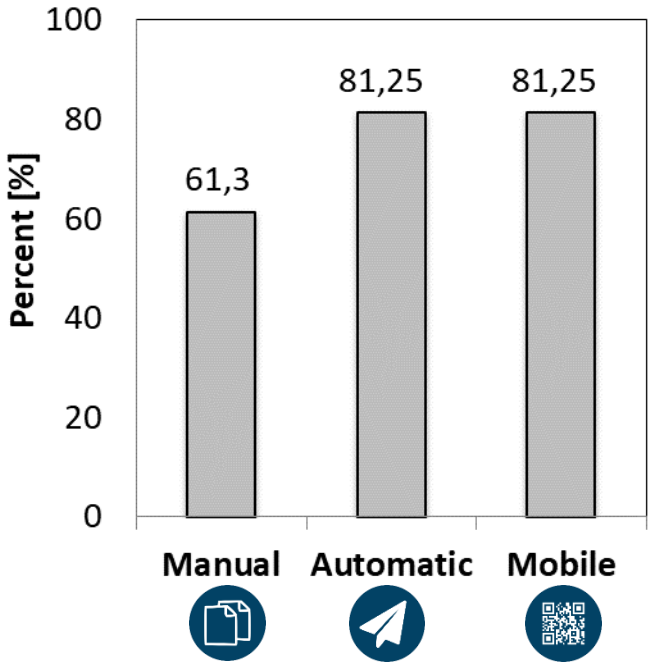
Procedure



- SUS questionnaire
- Additional questions

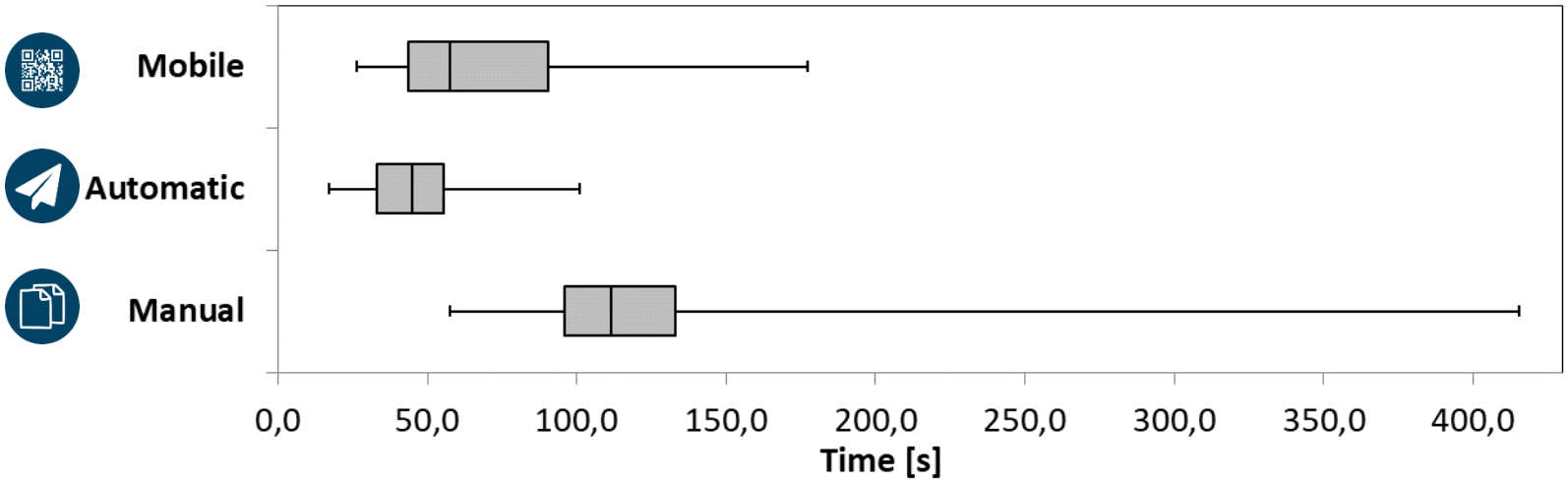
Collected Data: Effectiveness

- Completion rate
  - Share of subjects that verified successfully
- Determined by screenrecordings



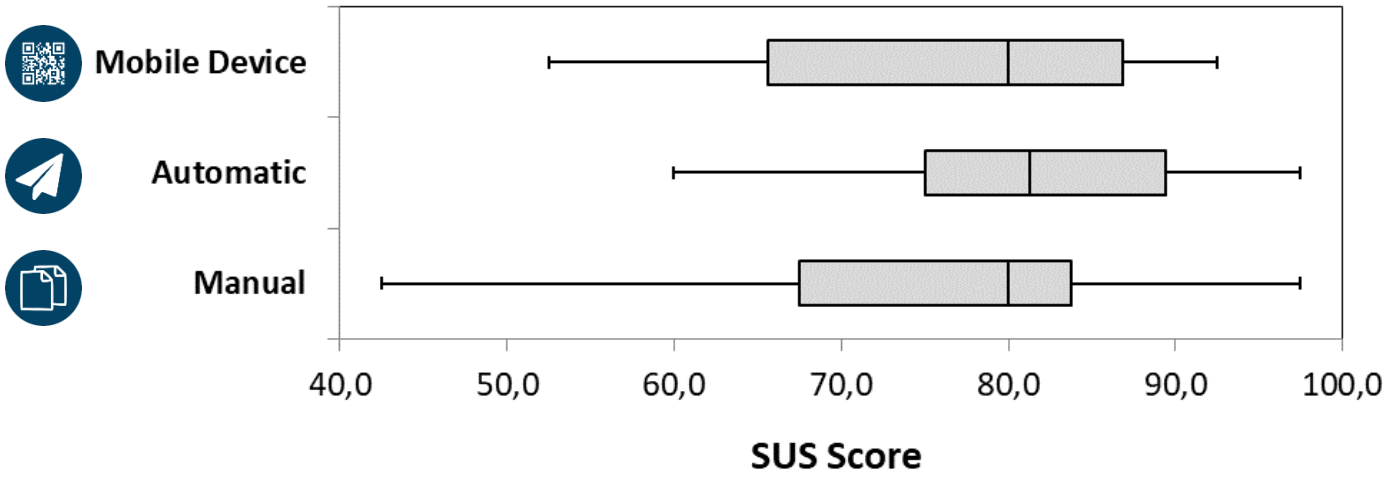
Collected Data: Efficiency

- Completion times:
  - Duration of the first successful verification
  - Logs by the software
  - Screenrecordings



Collected Data: Satisfaction

- System Usability Scale
  - 10 item questionnaire
  - SUS score from 0 up to 100



Collected Data: Additional

- Would you use the presented Internet voting system in a real Bundestag election?
- Would you use the presented verification option in a real Bundestag election?
- If you answered the question above affirmatively, how often would you perform verification?
- Did you experience any problems during vote verification?
- Did you experience any problems during vote casting?

Study Results

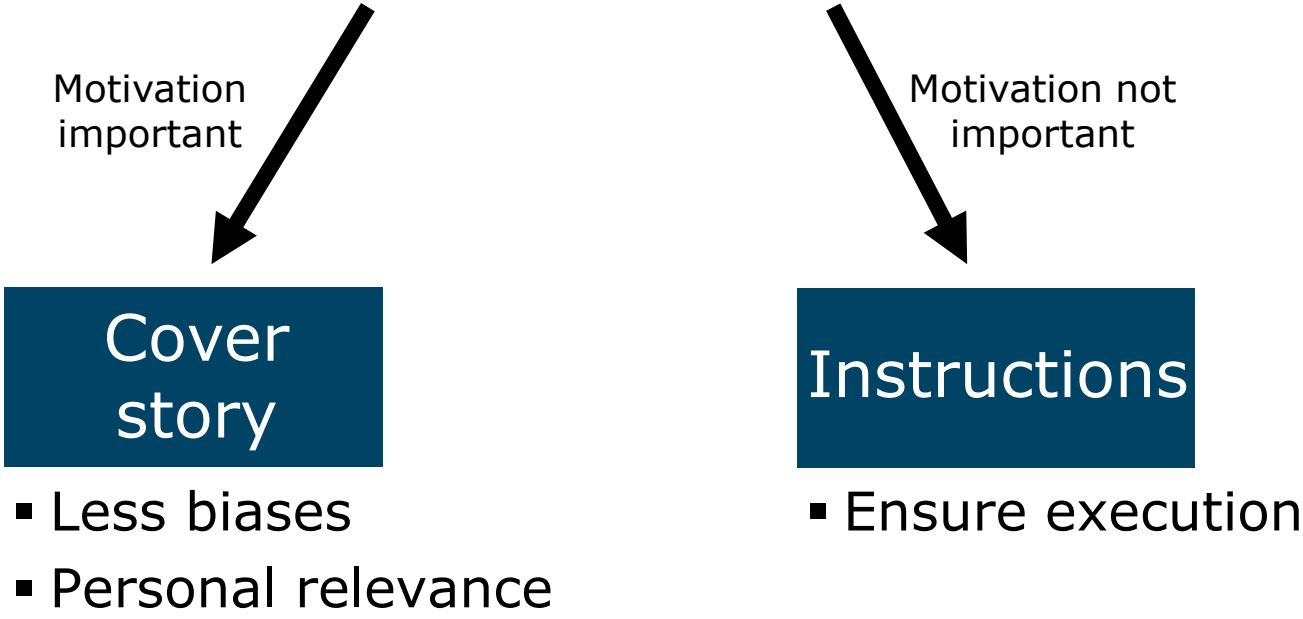
			
Ø – SUS	75,4	79,4	75,8
Completion rate	61,3 %	81,25 %	81,25 %
Ø – Time	131 s	47 s	61 s

Automatic is better than manual

Mobile is better than manual

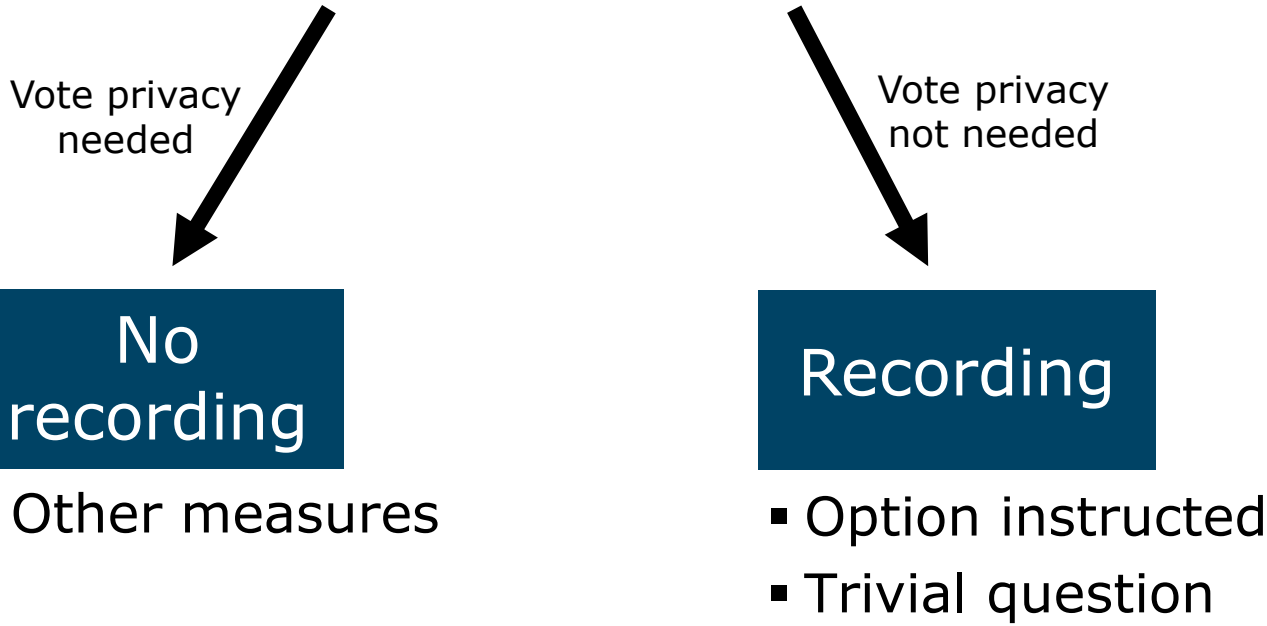
Lessons Learned – Motivation

- Participants have to be motivated to execute a task
- Usability does not include motivation



Lessons Learned – Vote Privacy

- Concerns the votes of the study participants
- Recording and observation break vote privacy



Lessons Learned - Effectiveness

- Actual comparison of data hardly detectable
  - Screenrecordings are not sufficient
  - Self reporting not reliable

Next Steps

- Long-term goal: Further research on c-a-i usability
- Next step: Evaluation of code voting vs. Benaloh
- Next-next step: Evaluation of other c-a-i approaches
  - Literature search for cast-as-intended approaches
  - Overview of available approaches
  - Classification of approaches

Discussion

- Mixing of understandability and usability
  - How can those concepts be seperated?
- Measuring of effectiveness
  - Are there other approaches to completion rates?
- Challenges in evaluation
  - Are there further challenges not mentioned in this presentation?

Backup Slides

Benaloh Challenge

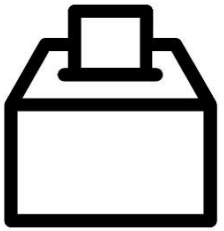
Benaloh Challenge

Verifier

Voter

Voting Device

Ballot Box



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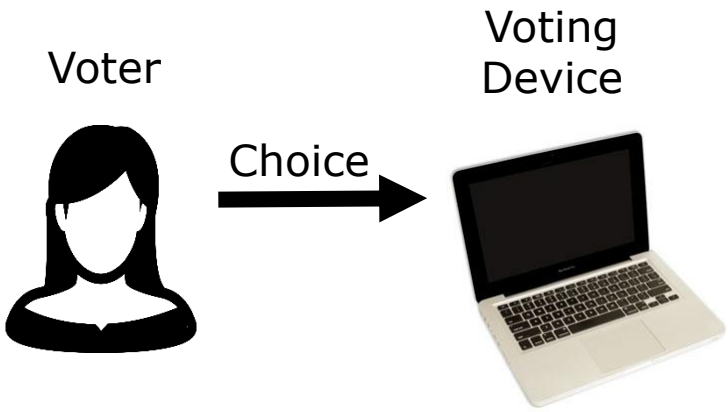
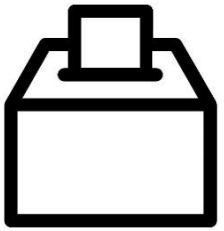


Verifier

Ballot Box



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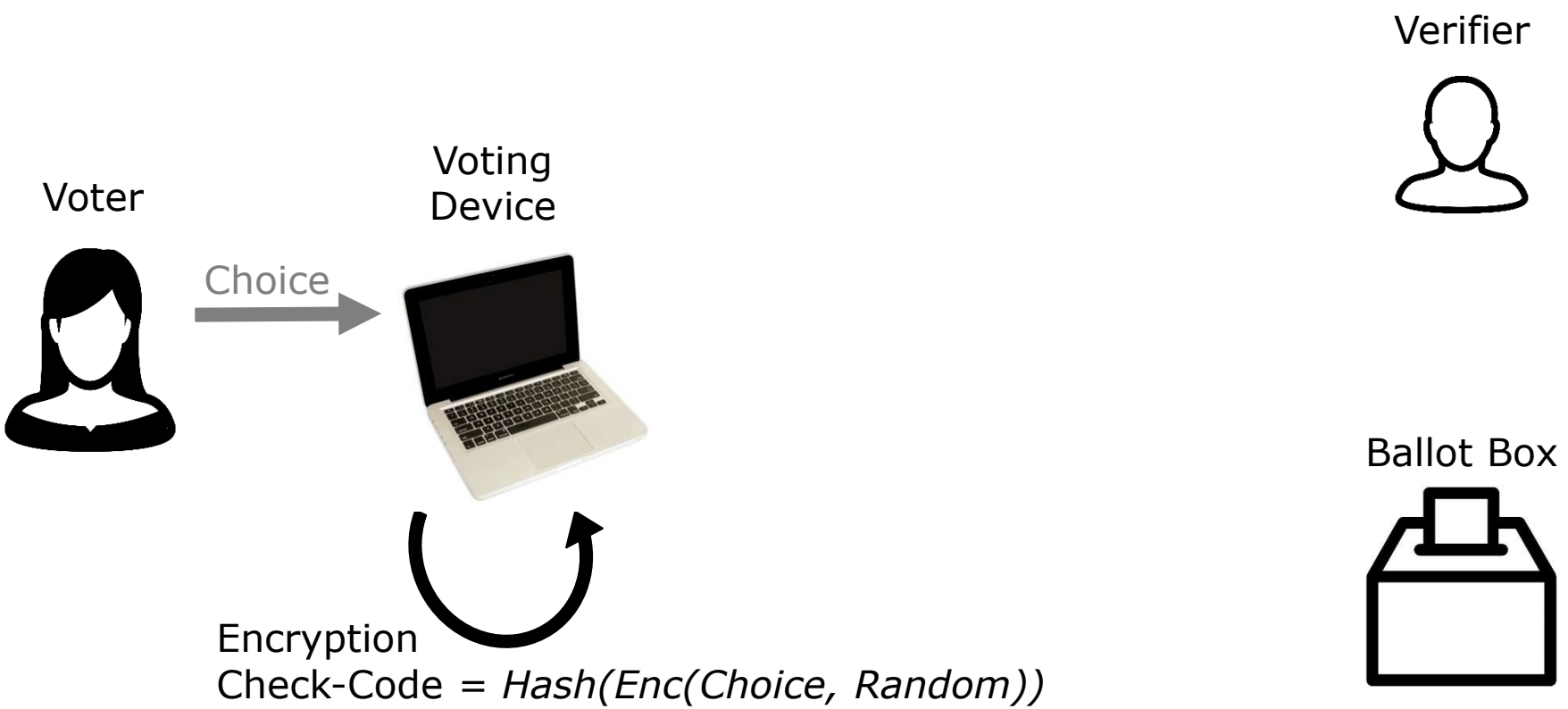

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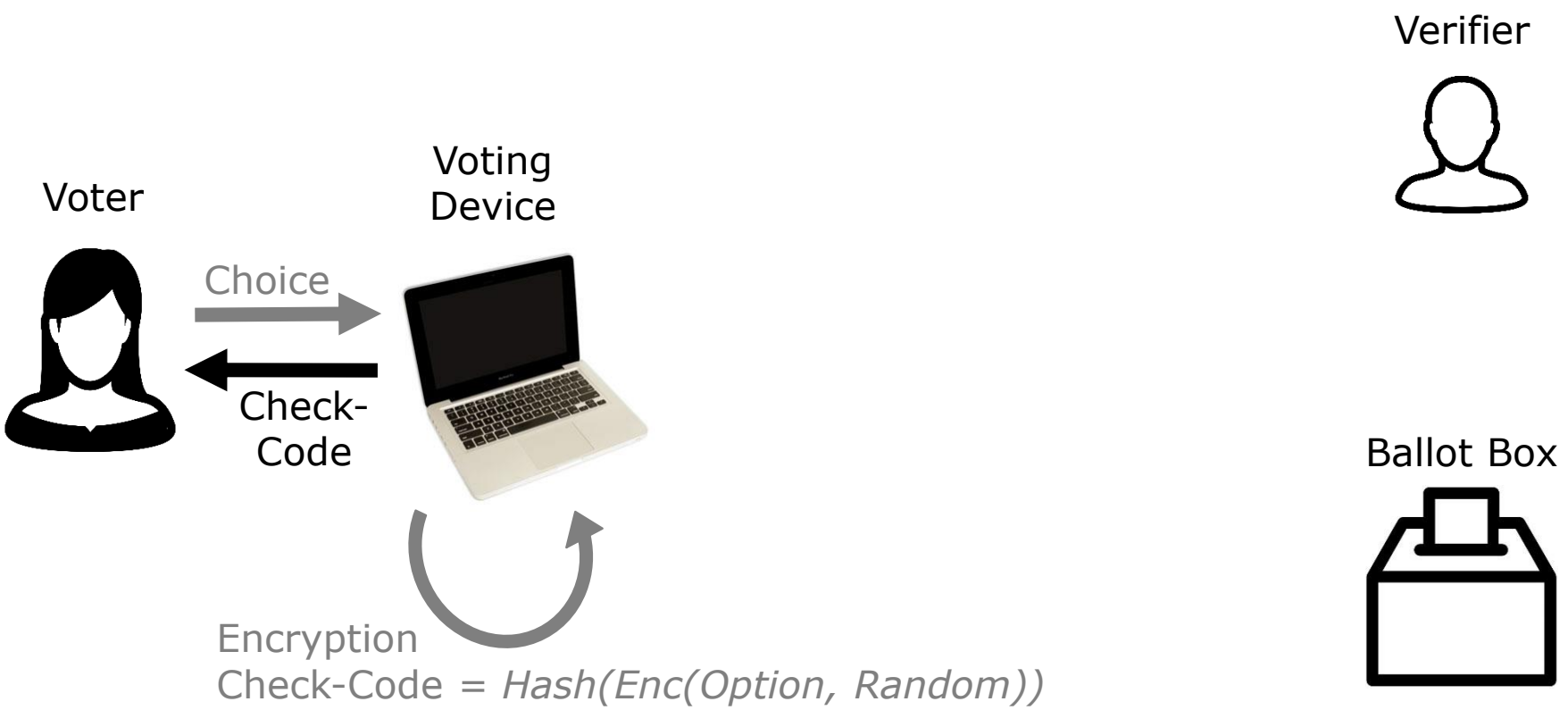

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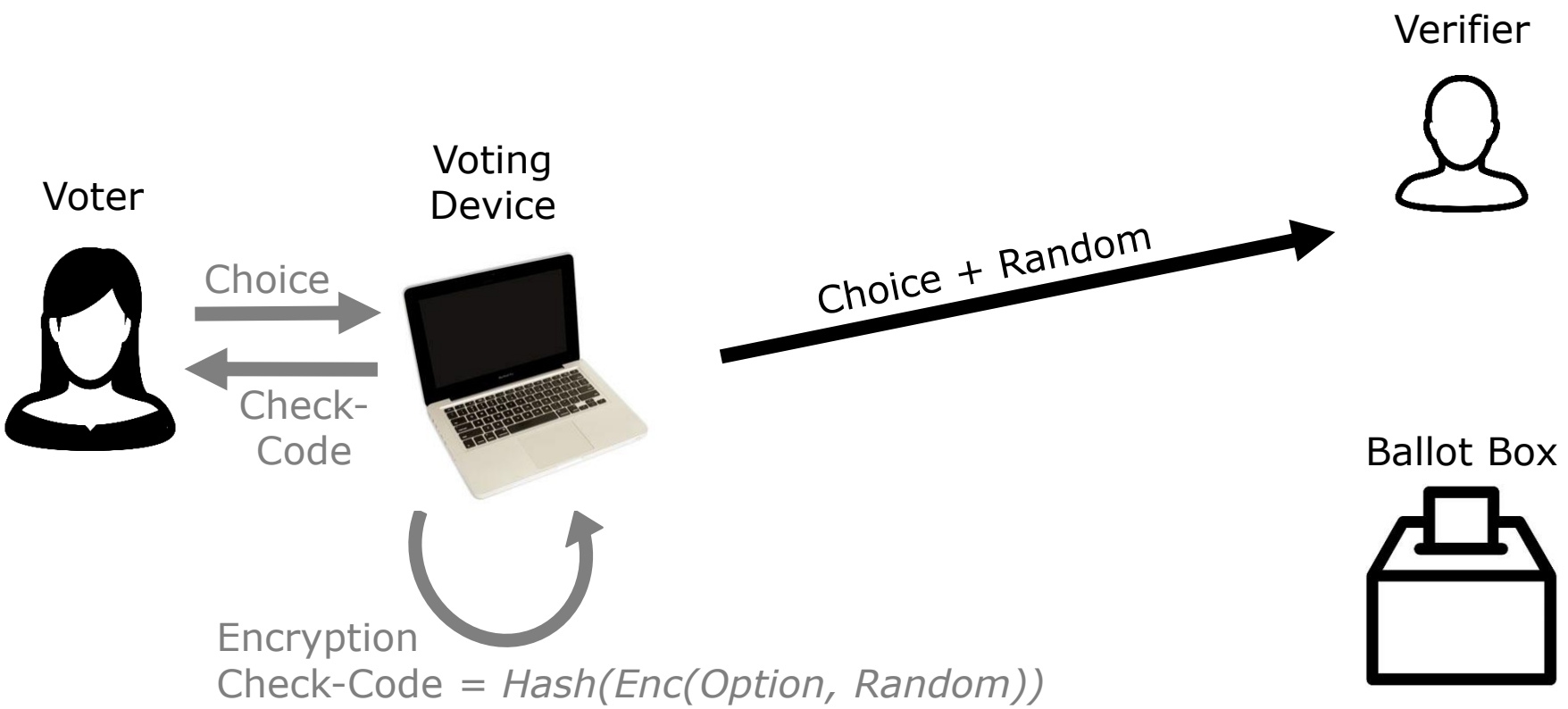

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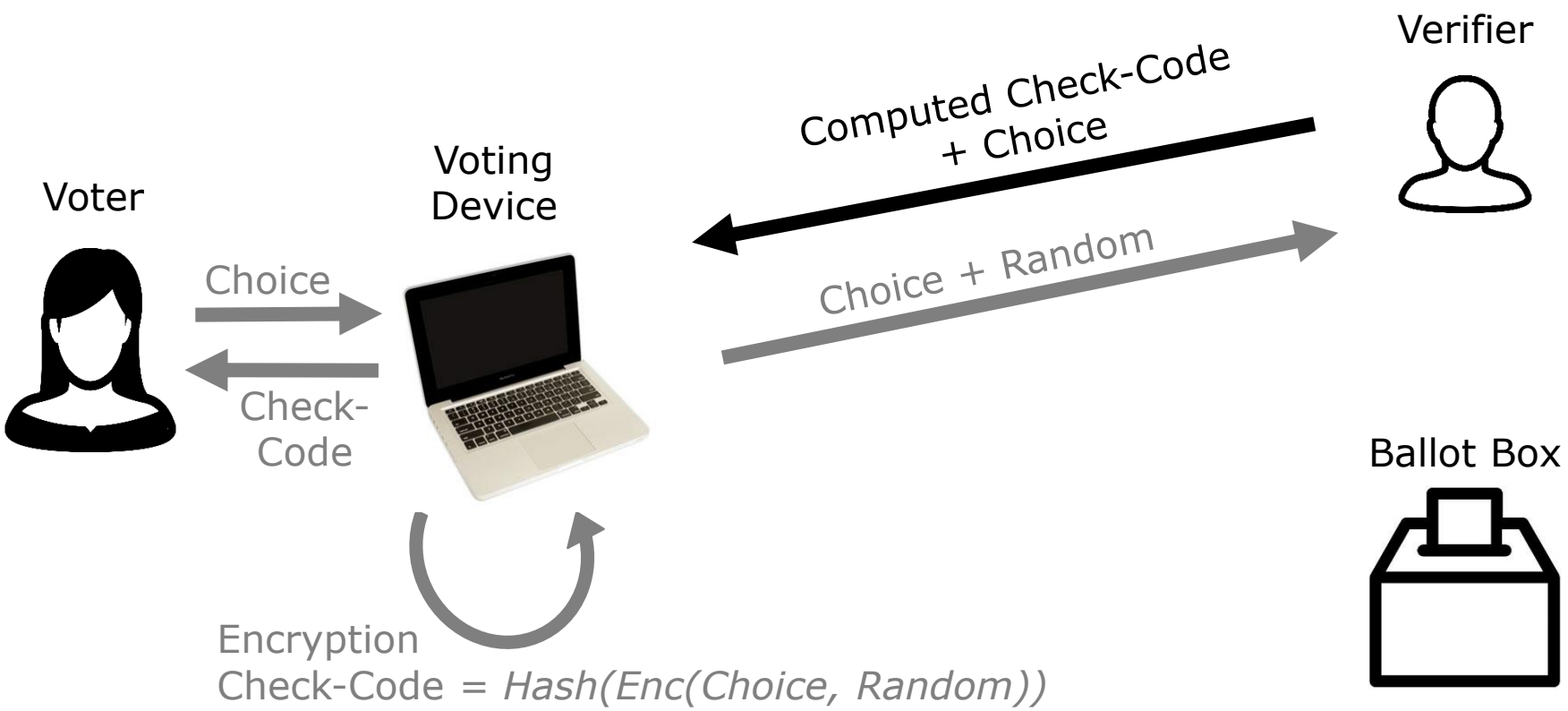

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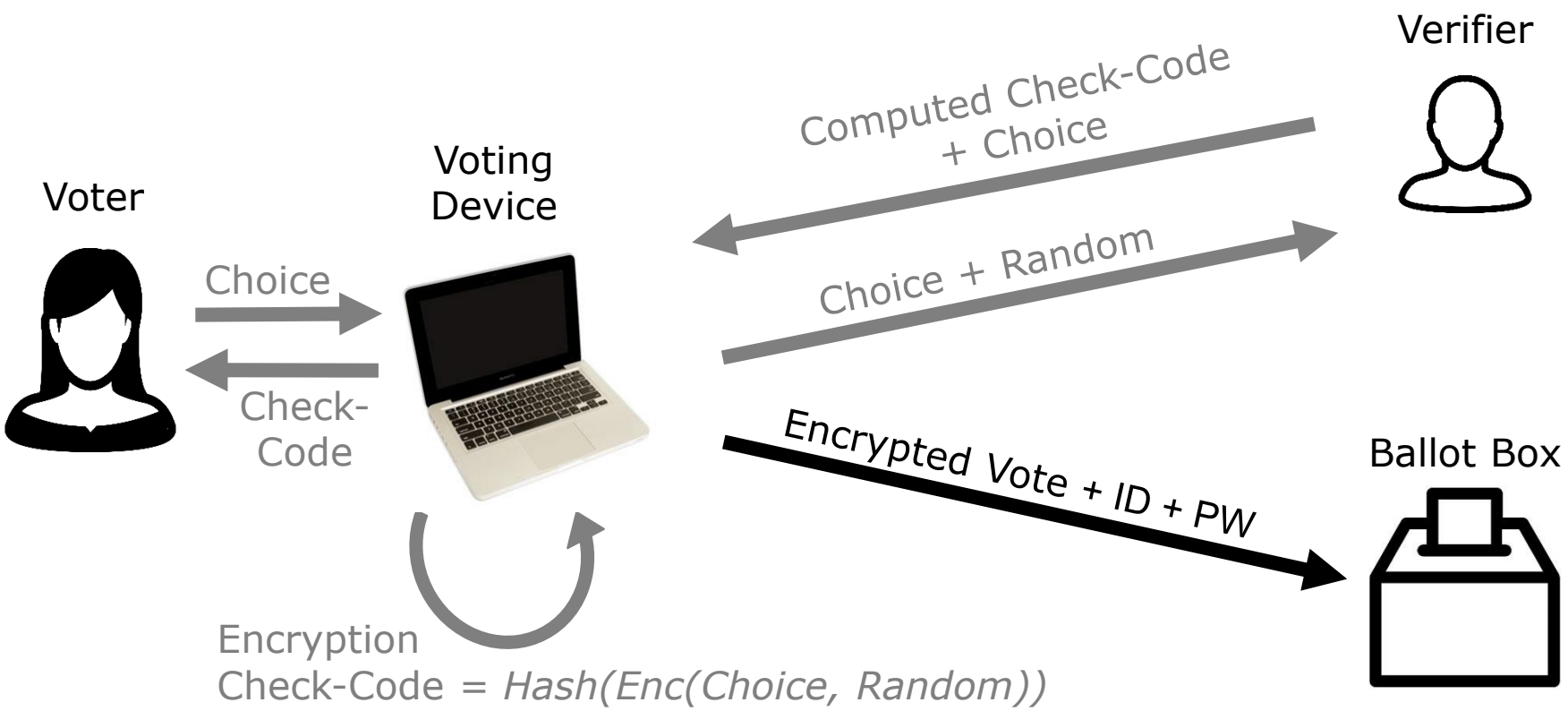

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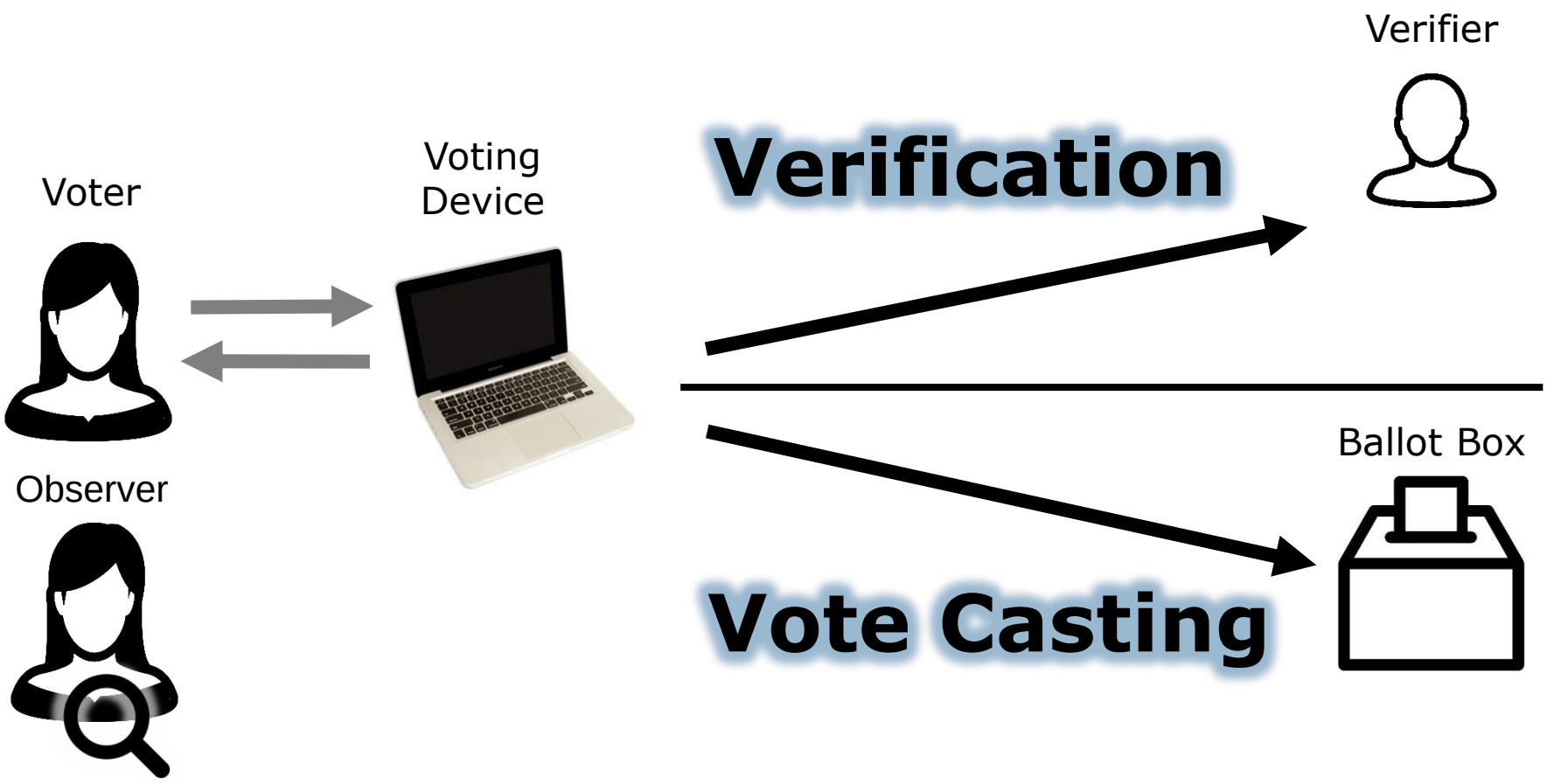


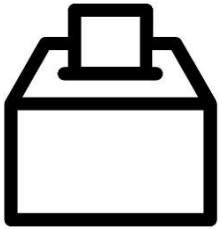
Code Voting

PUD

Voter

Voting Device

Ballot Box



PUD

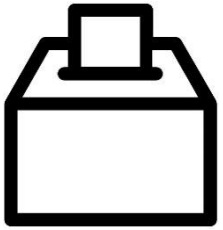
Code Sheet

ID: 34919	ID: 34919	ID: 34919
Fred Rubble	28502	93448
John Citizen	23983	62104
Jane Doe	45982	12937
Mary Hill	83410	89129
Joe Smith	29311	13812
–	94340	83429

Voter

Voting Device

Ballot Box



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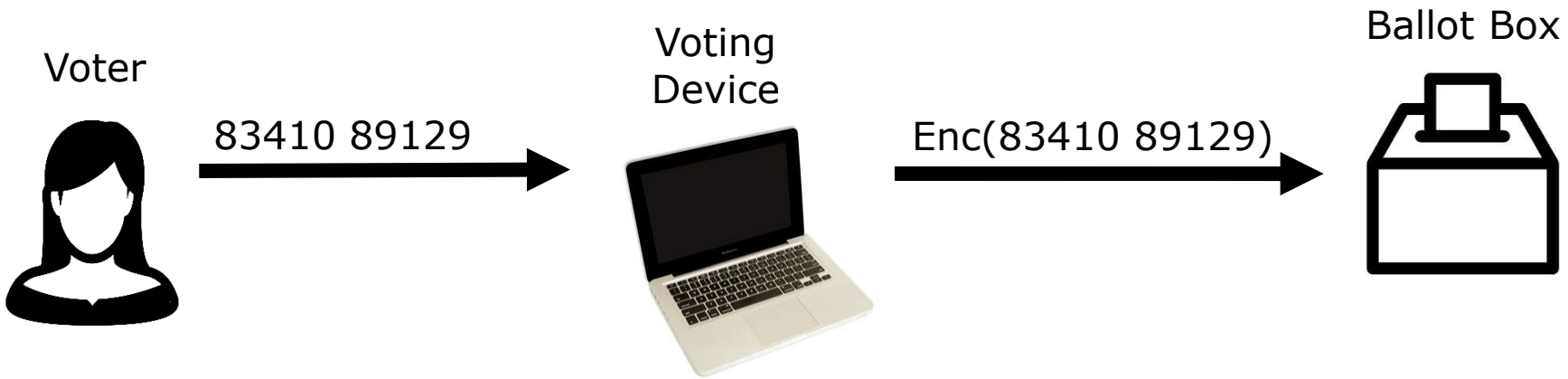

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