Universally Composable Auditable Surveillance

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Introduction

Ongoing debate

Law enforcement needs to be able to do constitutional searches

- Needs backdoors to anonymous systems

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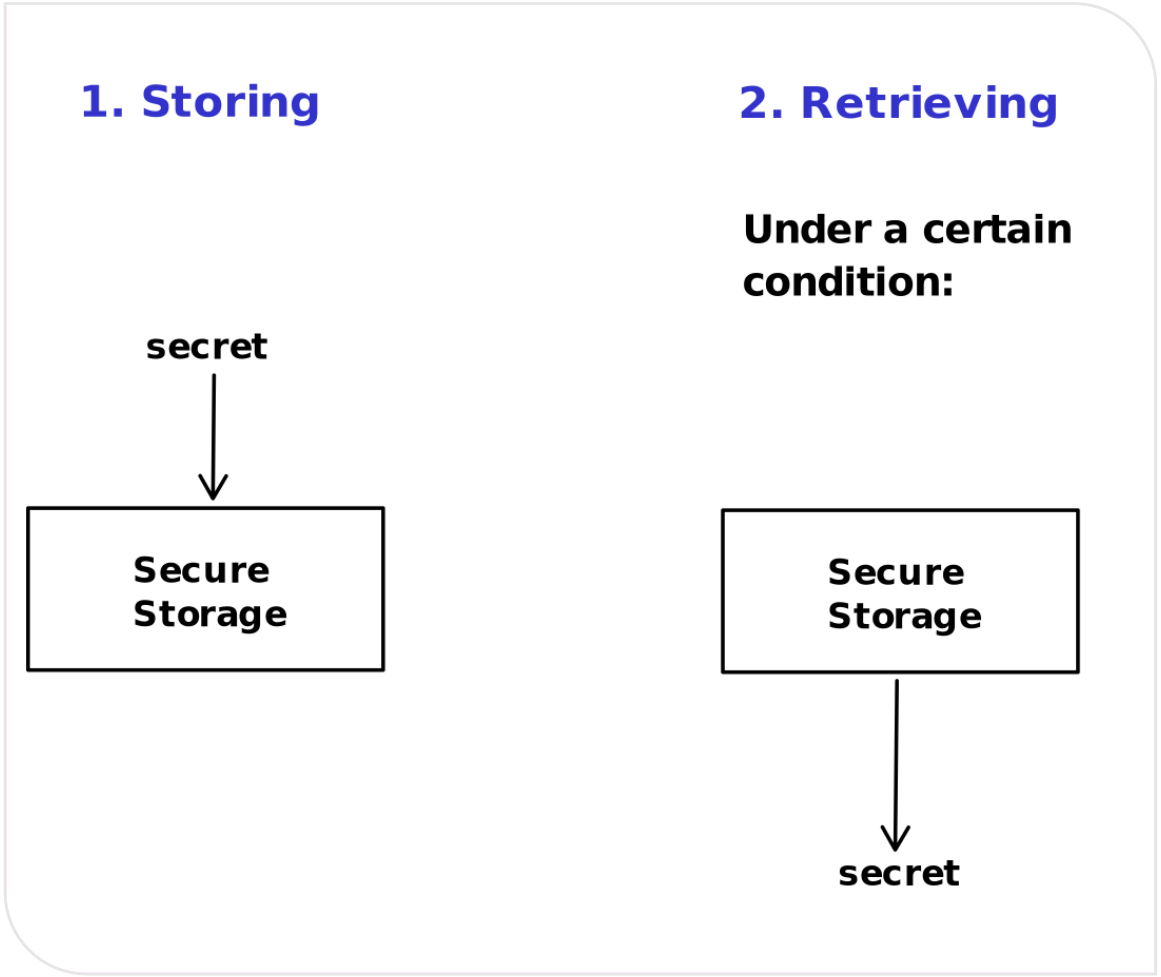
Our Research Question

How can we ensure in an auditable fashion that backdoors are only used for legitimate purposes?

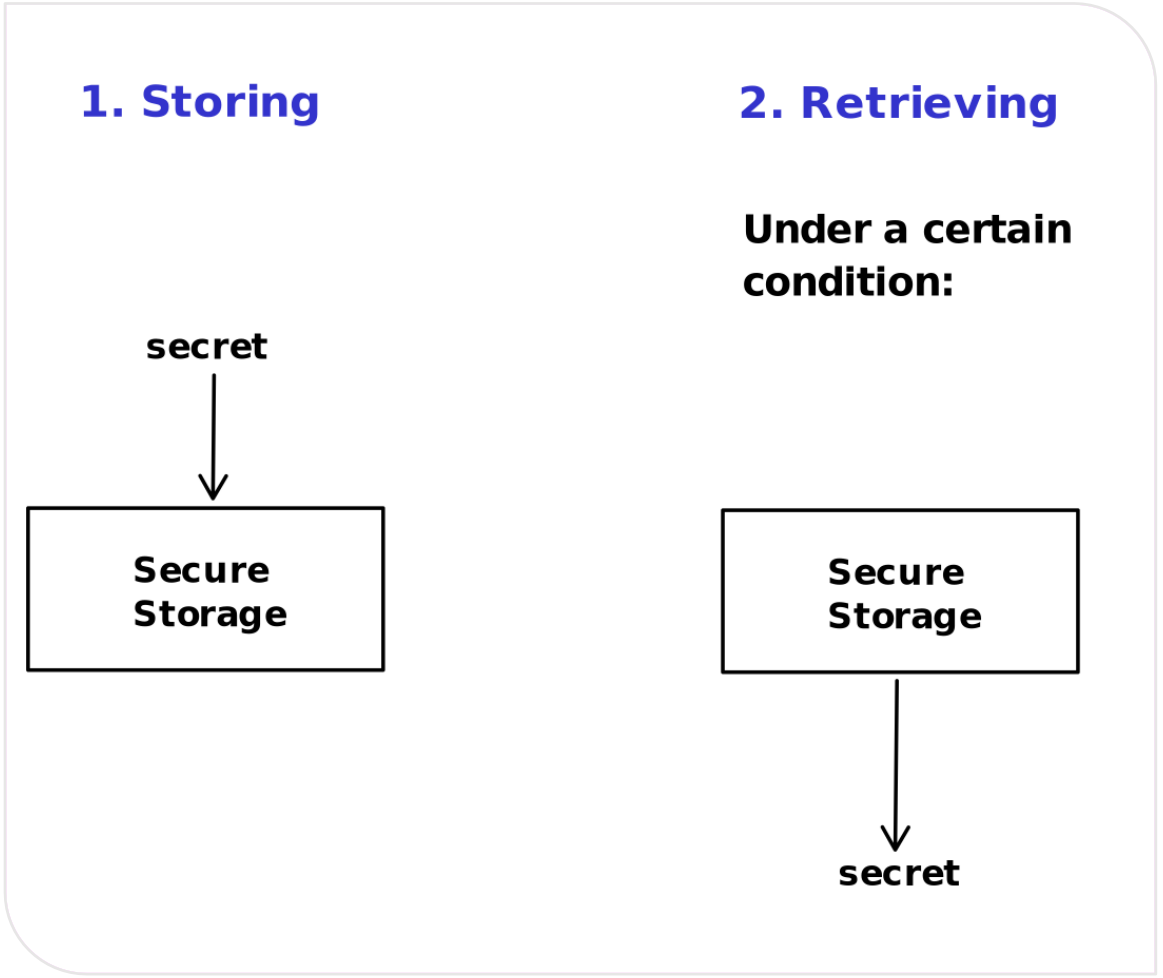
General Idea

- We have a secret (i.e., user-specific backdoor)
- We want to store it somewhere securely
- Only under a certain condition should the secret be released



Application Scenario: Anonymous Electronic Payments

1) Each user of the electronic payment scheme deposits a secret upon registration
2) User pays anonymously
3) If law enforcement suspects the user of money laundering, they can request the user‘s secret
4) Law enforcement can reconstruct all transactions of that user



Previous Methods and our Approach

- Key escrow mechanisms
  - Enable storage and retrieval of (user-specific) backdoors
  - But can be misused by the key escrow authorities (e.g., for silent mass surveillance)

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- ▶ Our approach: Combine both methods
  - Secrets/Backdoors are user-specific and only valid for certain time periods
  - Store encrypted secret somewhere, e.g., at system operator
  - Use ledger and an anonymous evolving committee to manage the key to decrypt secrets
  - Authorities must *first* publish proof that they are eligible to get the secret on the ledger and *afterwards* get the decrypted secret

Contribution

- Building block that allows to enhance existing protocols with auditable surveillance
- Modeled as an ideal functionality in the Universal Composability (UC) framework
  - To ensure that the system's security and privacy guarantees still hold if the system is run in combination with many different other protocols
- Protocol that realizes the ideal functionality
  - Uses PKE, threshold PKE, commitments, signatures, NIZK proofs, abstract ledger model, …

Parties

User

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System Operator

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Judge

- Grants or denies warrants

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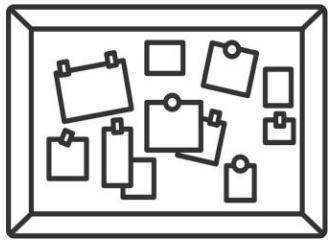

Committee Members

- Committee processes secret requests
- Communication with anonymous committee members through public bulletin board or append-only ledger

Store Secret & Payment Transaction

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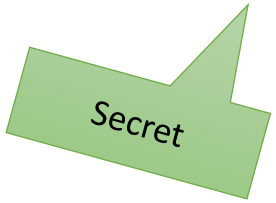

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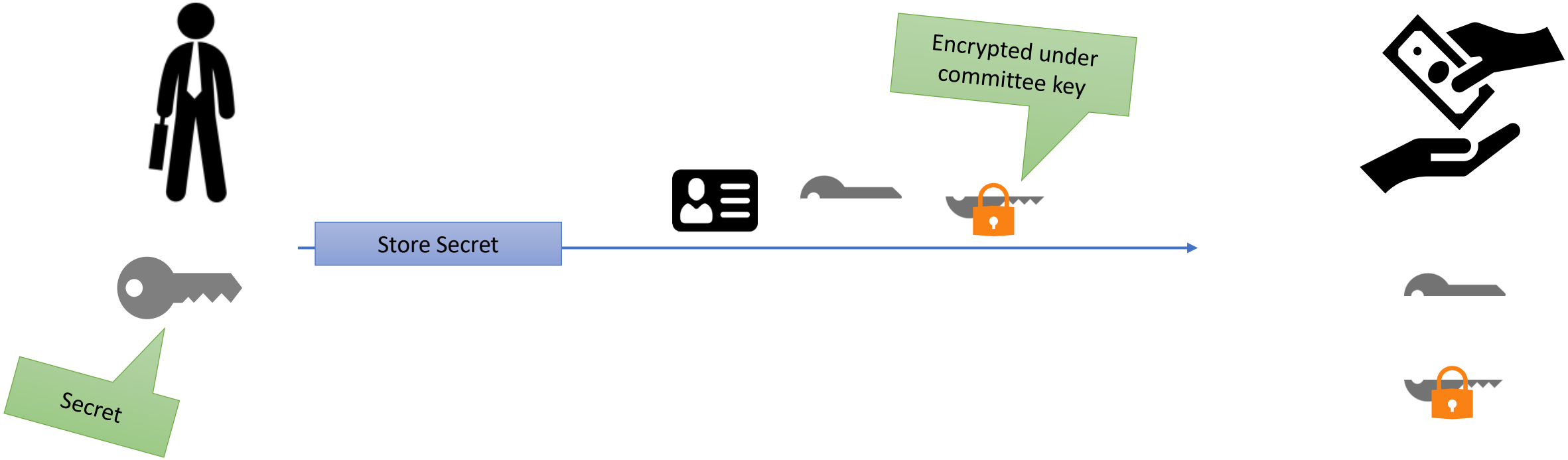

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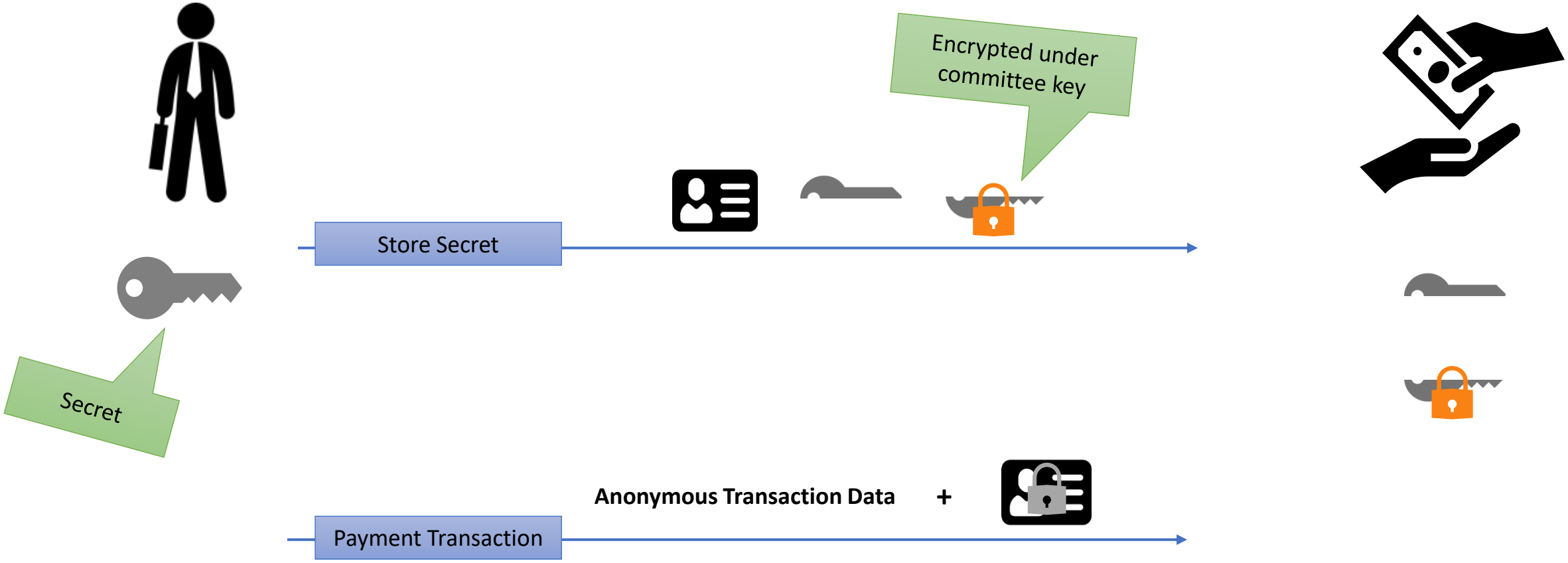
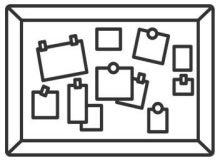


Requesting a Secret



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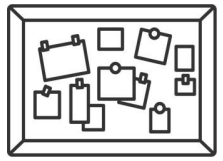

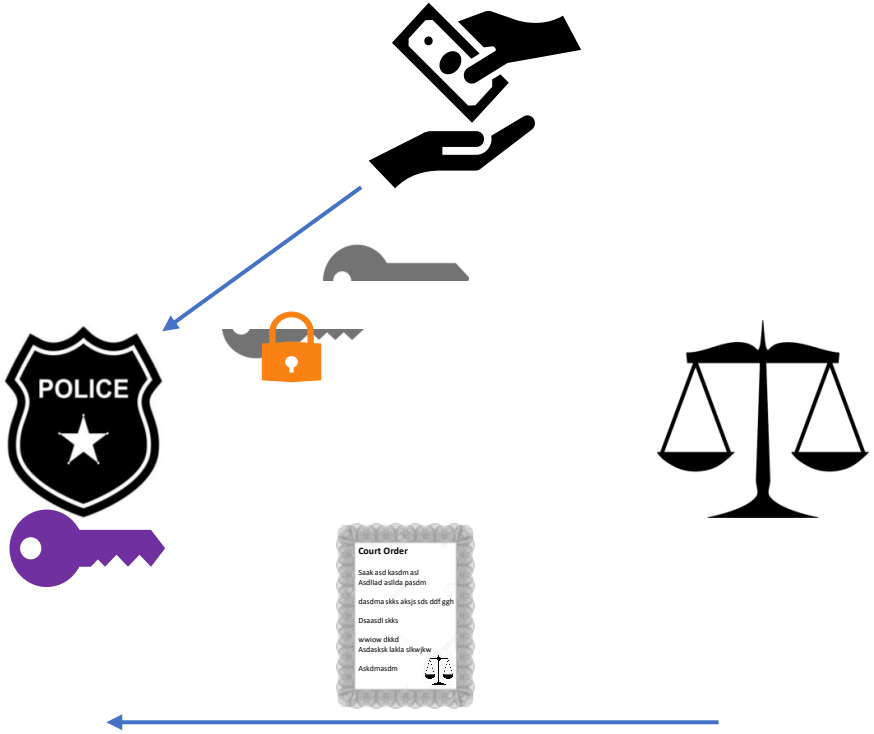

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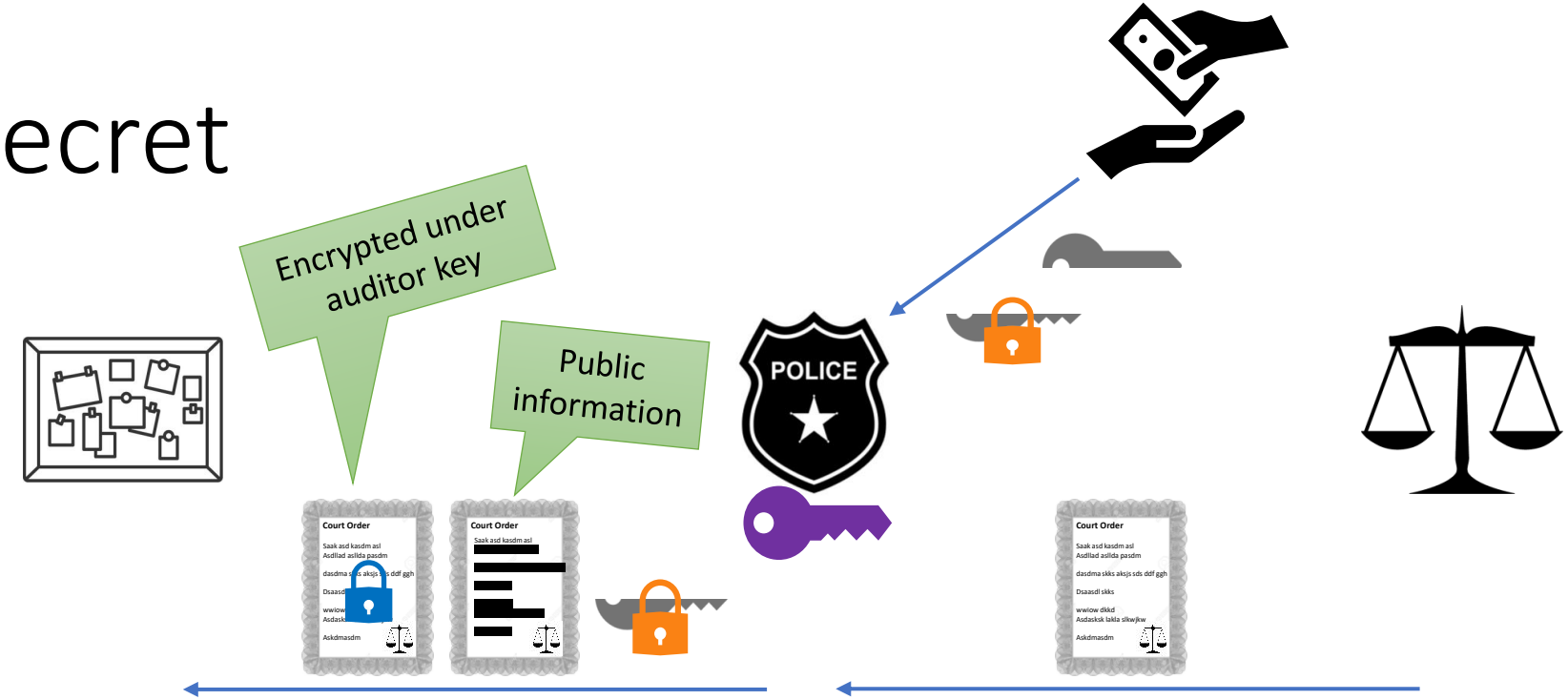

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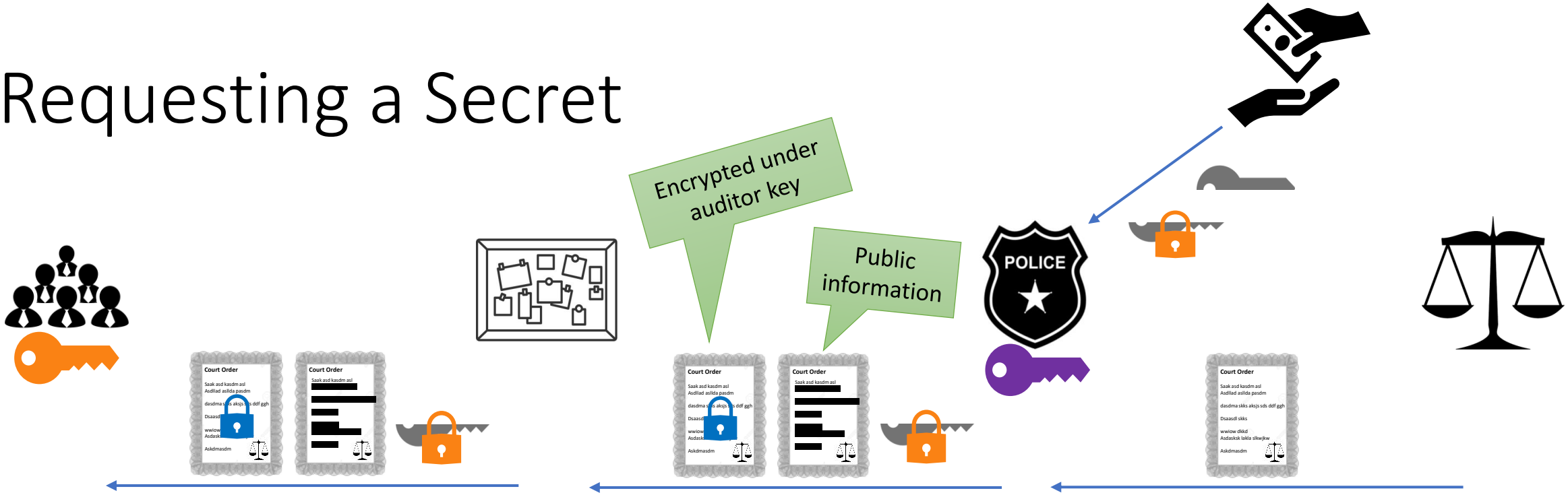

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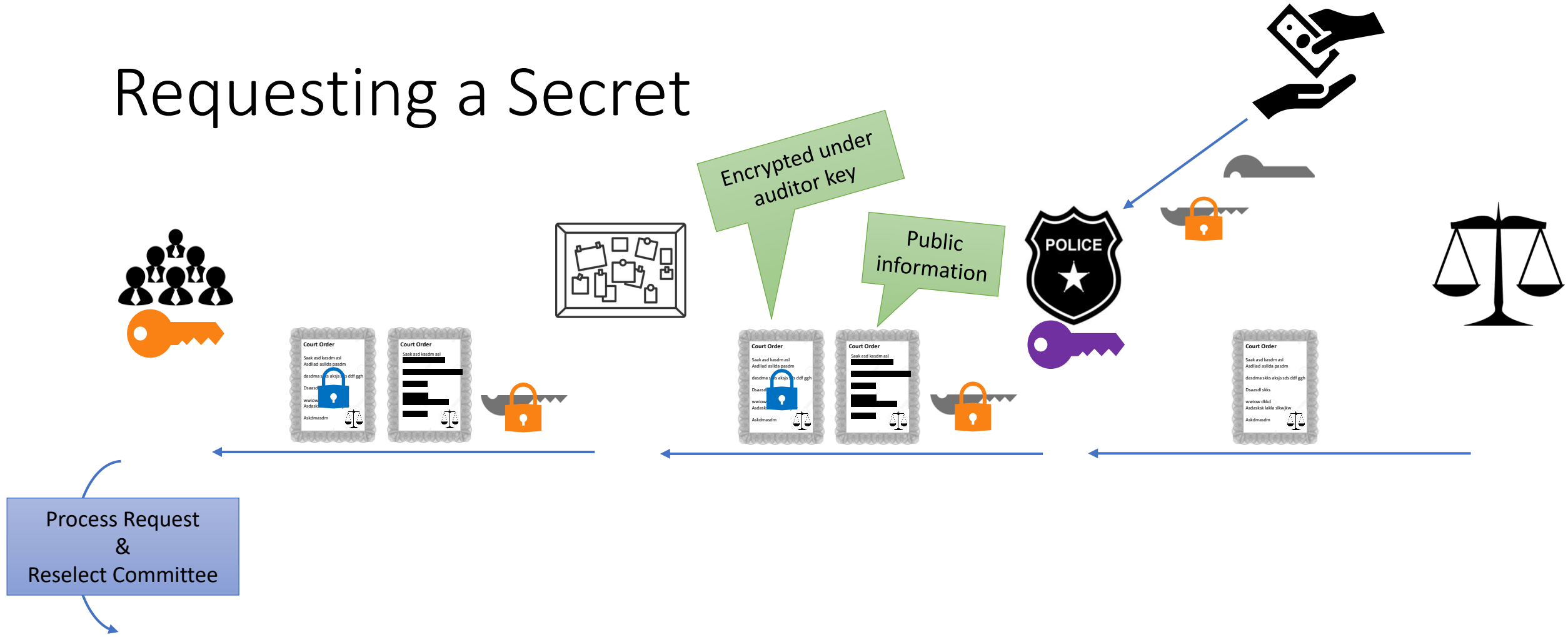

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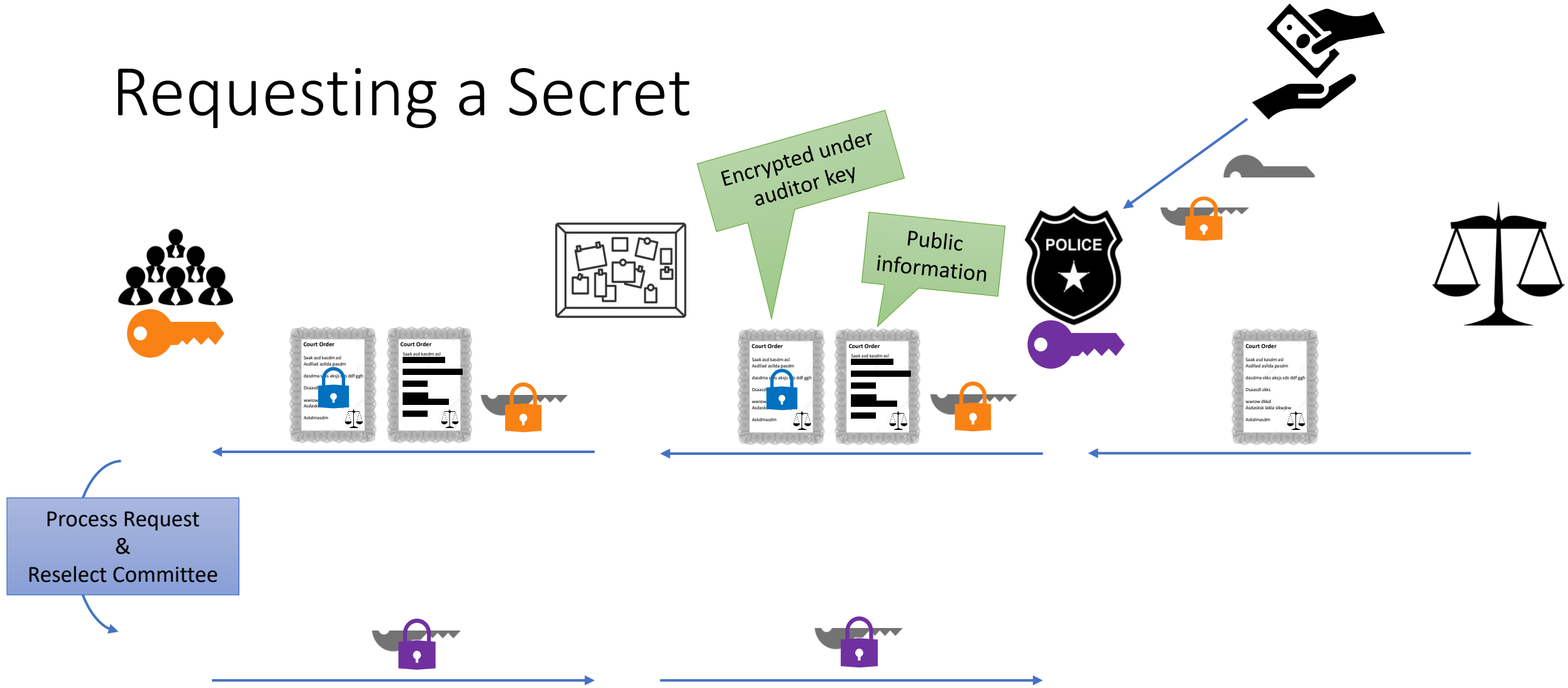

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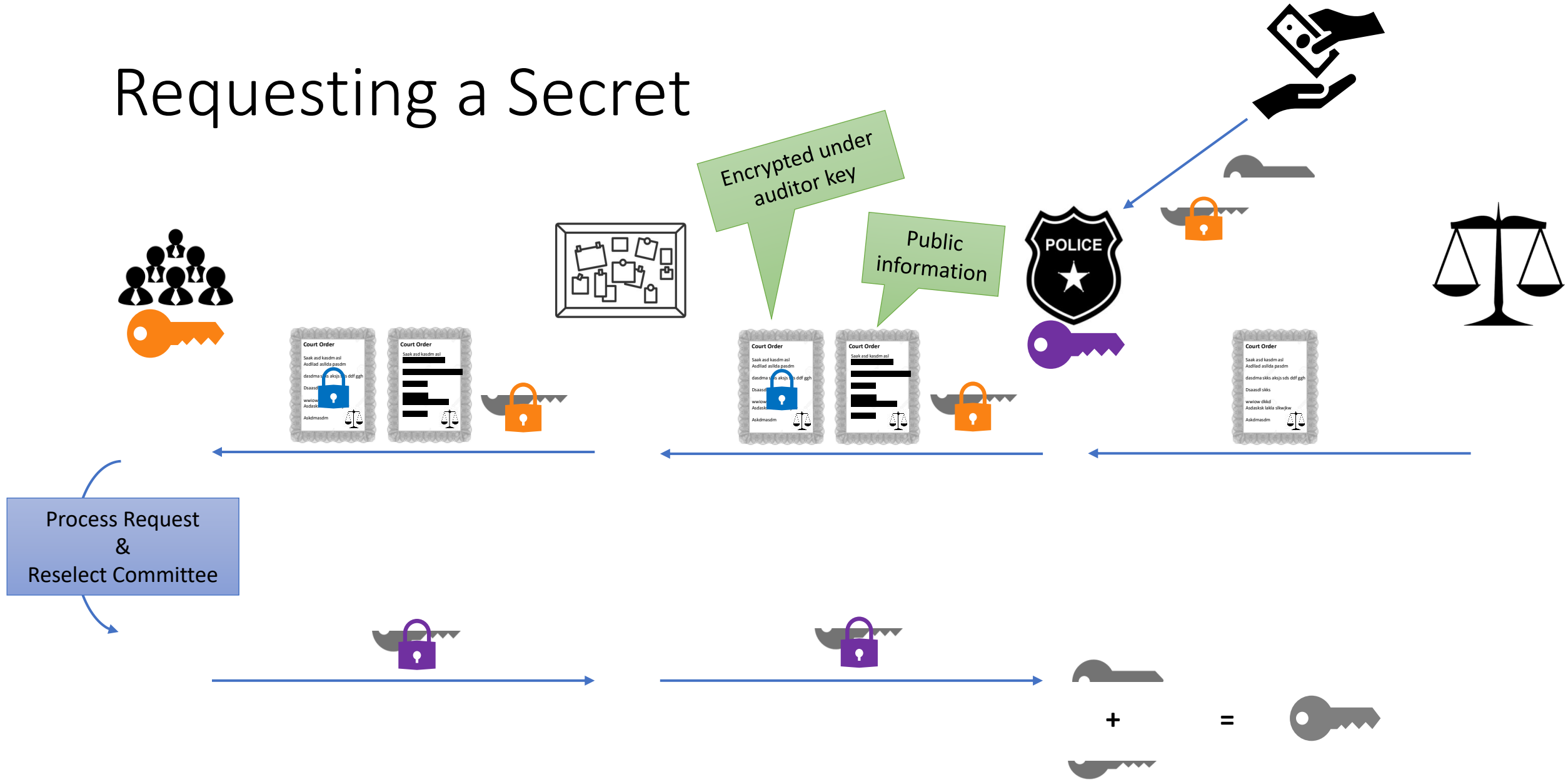

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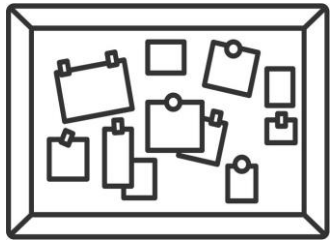

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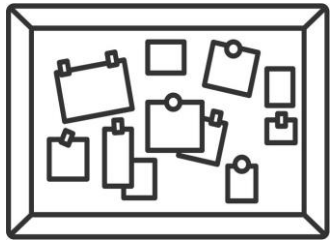

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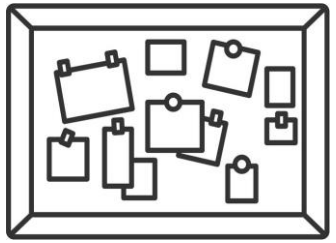

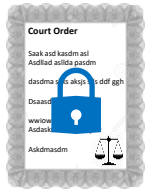

Can create simple statistics, e.g., number of requested secrets

Can retrospectively examine surveillance decisions

Protection Mechanisms for Escrowed Secrets

- Secrets are short-term and user-specific
- Secrets are shared between trustworthy parties to avoid a single point of failure
- Escrow secret access is given conditionally (judge-signed warrant needed)
- There are audit trails and public statistics for every (granted) secret request
- Surveillance is silent, i.e., users do not know they are surveilled

Properties of the committee

- We use an anonymous evolving committee to manage the decryption key on the ledger

- Modeled in the YOSO (You-only-speak-once) model [Gen+21]
  - ▶ Committee members are anonymous until they finished their work
  - ▶ Prevents targeted corruption of committee members
  - ▶ Security against mobile adversaries

[Gen+21] Gentry et. al., “YOSO: You only speak once: secure MPC with stateless ephemeral roles”. CRYPTO 2021.

Conclusion

- Contributes to the current debate between law enforcement and privacy activists regarding the "need" for back doors
- Present a UC-secure building block to augment existing applications with auditable surveillance capabilities
- Backdoors are protected in mutliple ways

Thanks!

https://ia.cr/2023/1343