Availability vs Confidentiality
of Electronic Health Records

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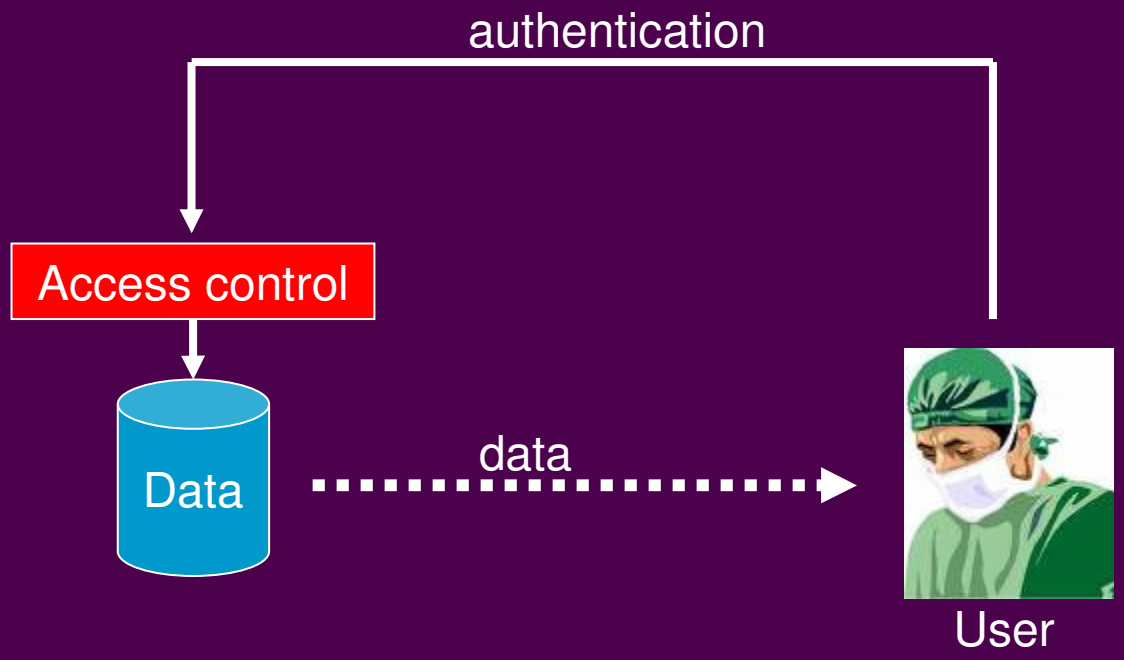
Clinical vs Traditional systems

- Complex Rules defining Access
  - No simple “this user has access to this data”
  - Conditions under which access is granted are complex
    - “Analyst X can only access a patient’s record if the patient’s Cholesterol level exceeds Y mg/dL”
    - Access conditions may evolve as the patient is being treated
  - Emergency situations
- Highly heterogeneous
  - Data exchanged between various systems
  - All systems must respect the same security policy

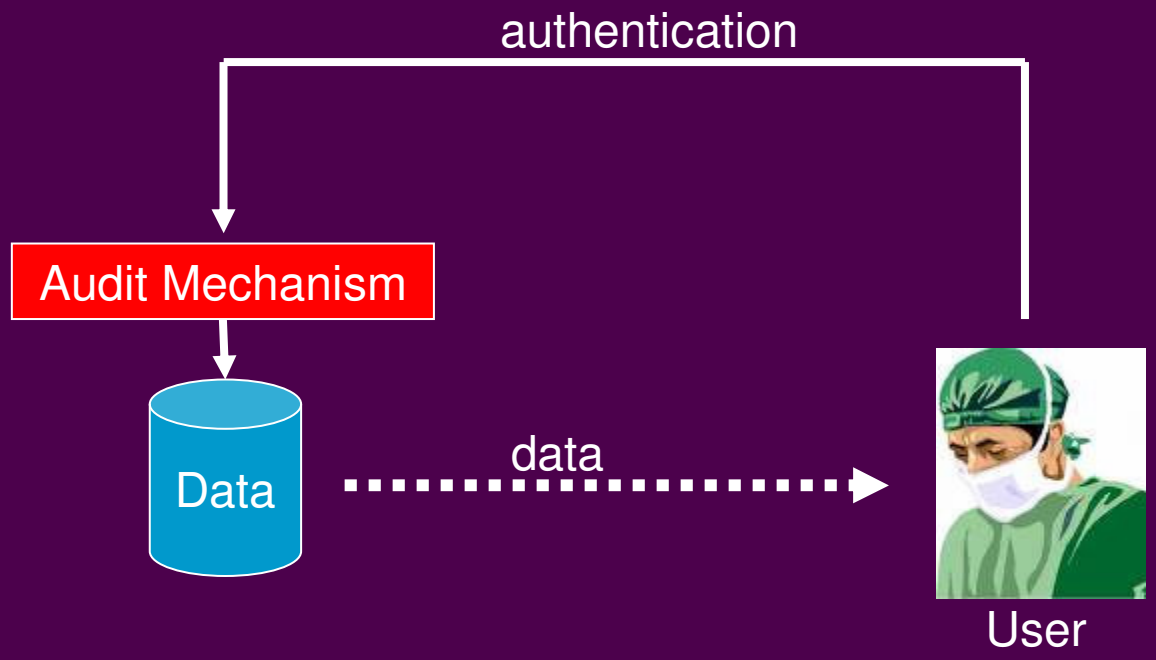
Access control

- A priori: lower availability
- A posteriori: accessors must be able to justify their audited accesses
- “Audit-Based Access Control”

Traditional scheme



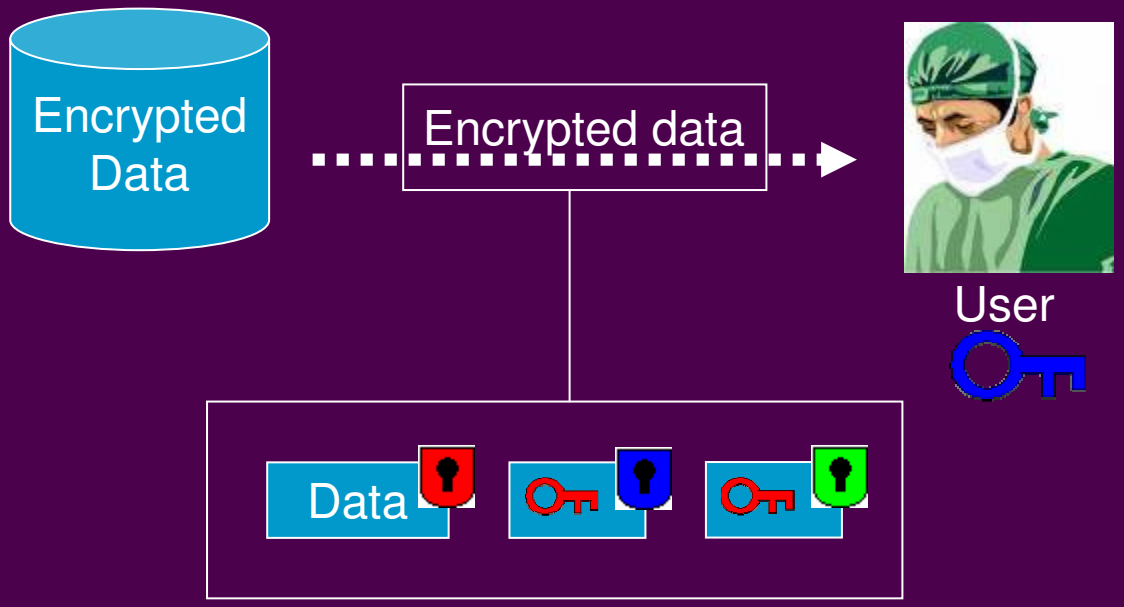
A posteriori scheme



Data exchange and Security

- Traditional systems: data and access control are easily separatable
  - Security of data depends on security and compliancy of the environment it resides in
- Cryptographic access control: data and access control are inseparatable
  - Access policy moves along with the data

Cryptographic scheme



The problem

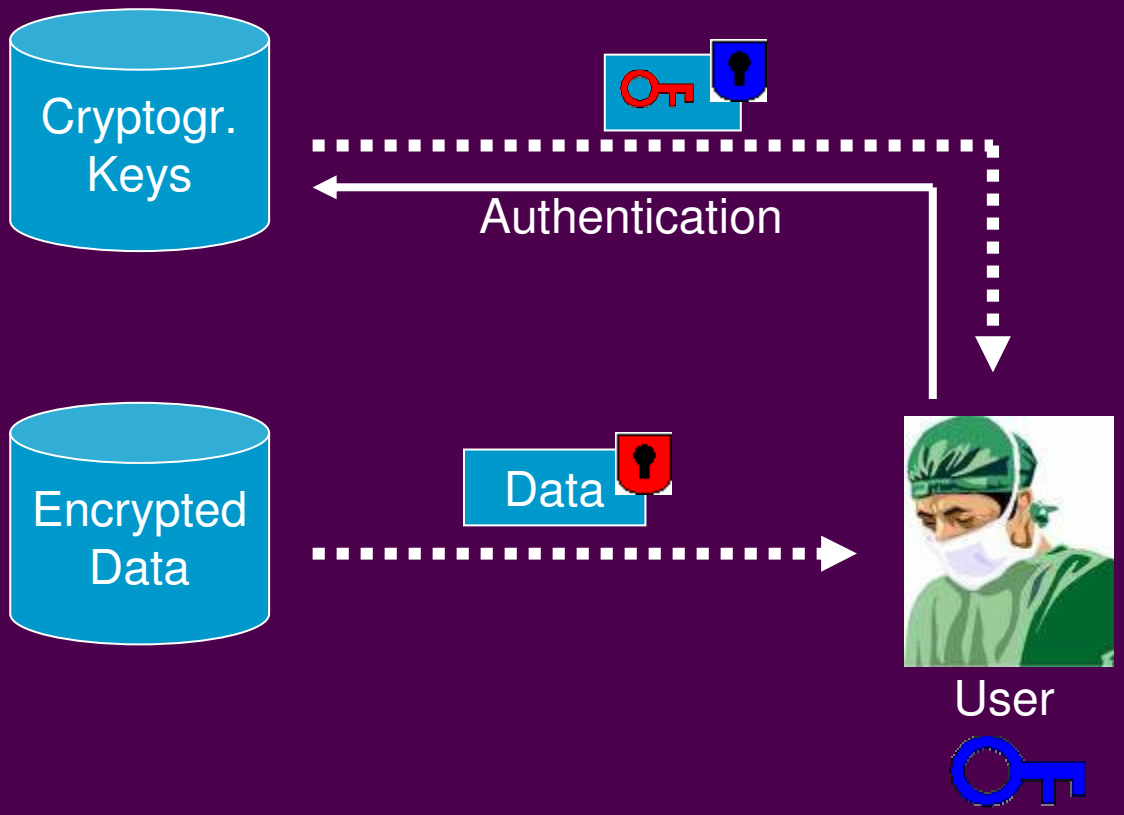
- How can we have the availability of audit-based access control and the confidentiality of cryptographic access control?

Cryptographic scheme

- Authorized persons are known *a priori*
- In audit-based access control any* user should be able to access

- Keep the key at a “safe place” and allow recovery by any* user

Escrowed scheme



Escrowed scheme

- Escrow by a single agency requires a high amount of trust in that agency
- Can we relax this requirement by using more agencies?

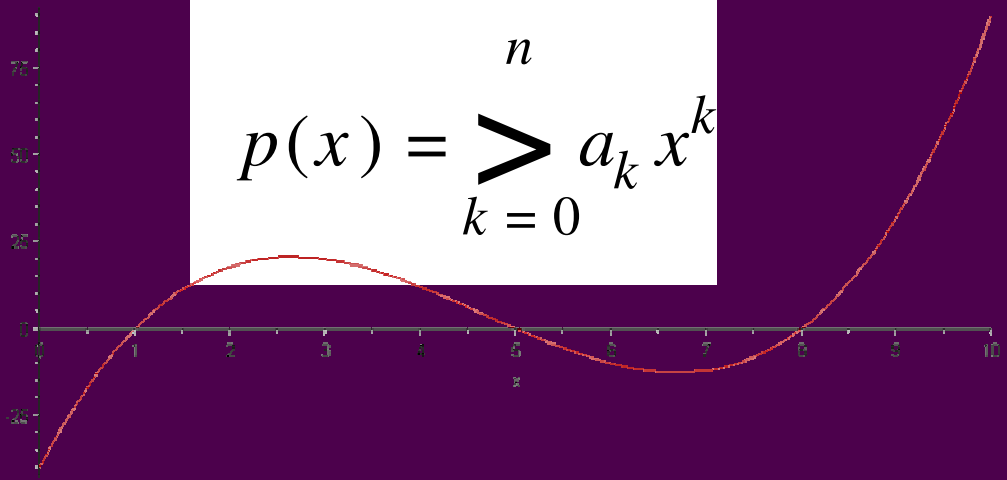
- Yes we can

Partial key escrow

- The idea: an escrowed key is not stored explicitly, but rather implicitly as something that can be reconstructed if a number of agencies collaborate
- Required trust in a shareholder is less than when using a single escrow agency

Secret sharing

$$p(x) = \sum_{k=0}^{n} a_k x^k$$



- Secret: p(0)
- Reconstruction by interpolation
- Distribute (x_i, y_i) among group of m members (m > n, $x_i \neq 0$)

Partial key escrow

- An attacker must gain access to all the shares. Can we trust that an agency never releases its share?
- Can we make it harder for the attacker to reconstruct the secret?
- Yes we can

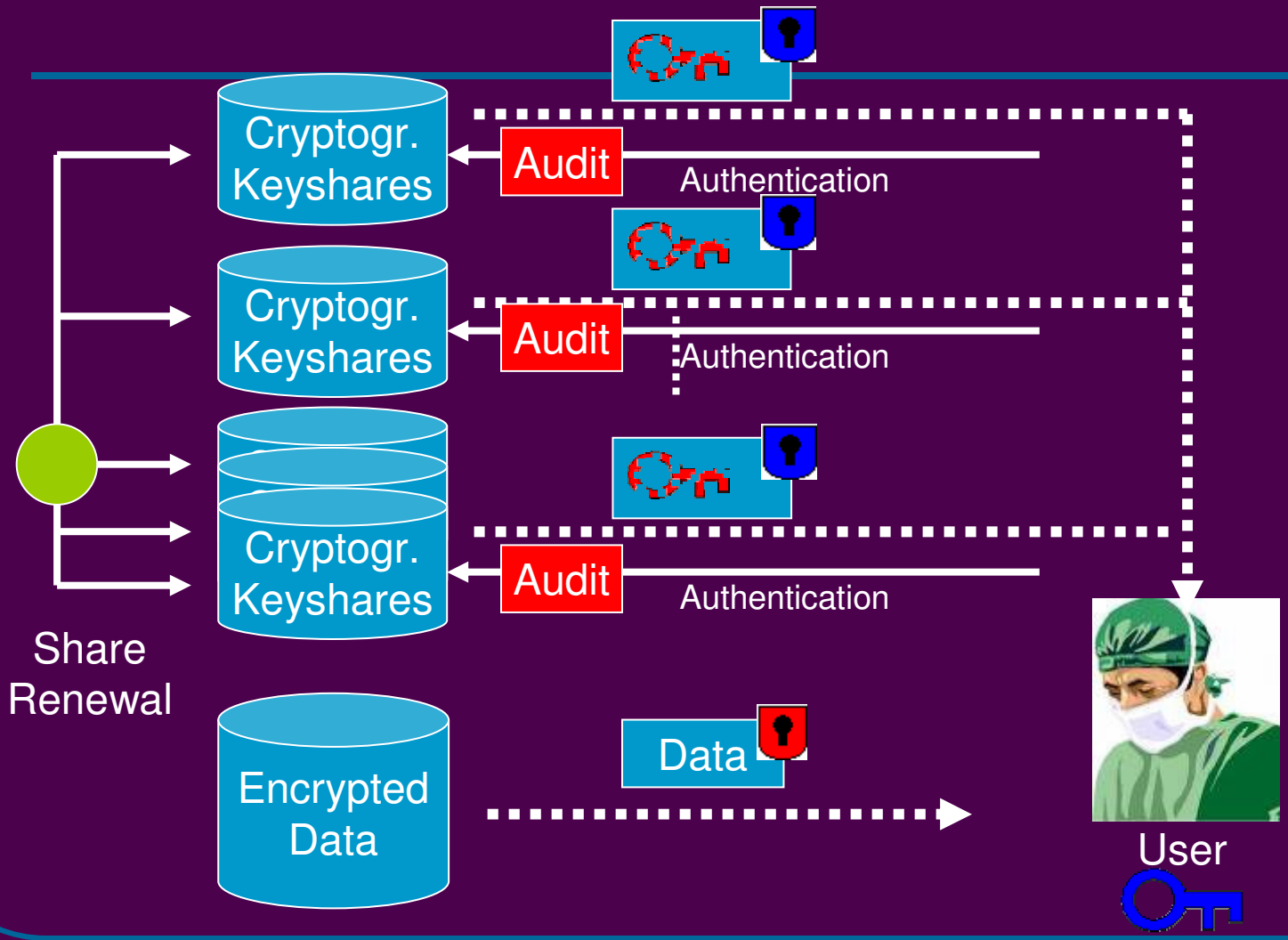
Proactive secret sharing

- *SS(X)* :
  Secret-sharing scheme with secret *X*
- *SS(X)* + *SS(0)* = *SS(X)*
- In the new scheme only the shares have changed, *not* the secret

Auditing

- Can be done at the escrow agencies
- Auditing only fails if n + 1 agencies fail to audit

Proposed scheme



Questions?