Privacy Engineering in DRM Systems

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The reality of web privacy…

CHEAP TICKETS inc

- To search for fares:
  - unique subscriber ID
  - full name
  - e-mail address
  - home phone
  - work, fax number (opt)
  - traveling partners (opt)
  - preferred airport (opt)

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The New York Times ON THE WEB

- To browse news content:
  - unique subscriber ID
  - e-mail address
  - country
  - zip code
  - age
  - sex
  - household income (optional)

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- Valuable

The New York Times ON THE WEB

- To browse news content:
  - unique subscriber ID
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  - country
  - zip code
  - age
  - sex
  - household income (optional)
- Why not? It's easy…

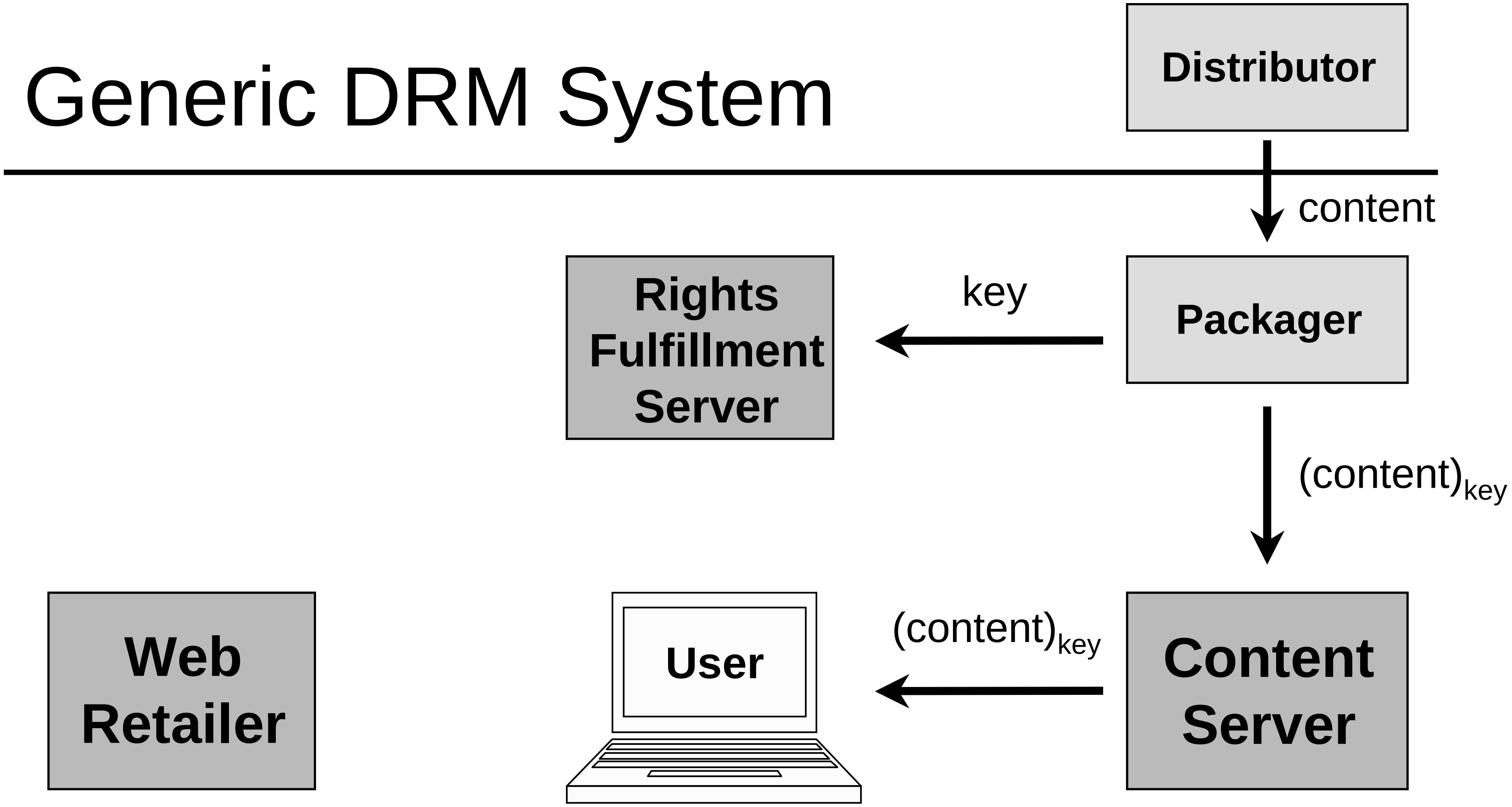
DRM: a hard privacy playground

- Focus of this talk
  - Mass-market DRM-enabled content distribution on the Internet
- Inherent tension
  - Copyright enforcement goals of **copyright owners** vs.
  - Privacy goals of **consumers**
- Privacy threats
  - Information about consumed content is privacy-sensitive
  - Information centrally aggregated by few players
  - Actual usage information collected
  - Devices linked to personally-identifiable information (PII)

Outline

- A generic DRM architecture
- Assertion: Crypto doesn’t solve privacy in DRM
- Real goal: Privacy abstractions for good practices
- Needed:
  - Practical methodology for privacy engineering
  - Enforcement procedures

Generic DRM System



Distributor

content

Packager

key

Rights Fulfillment Server

(content)$_{key}$

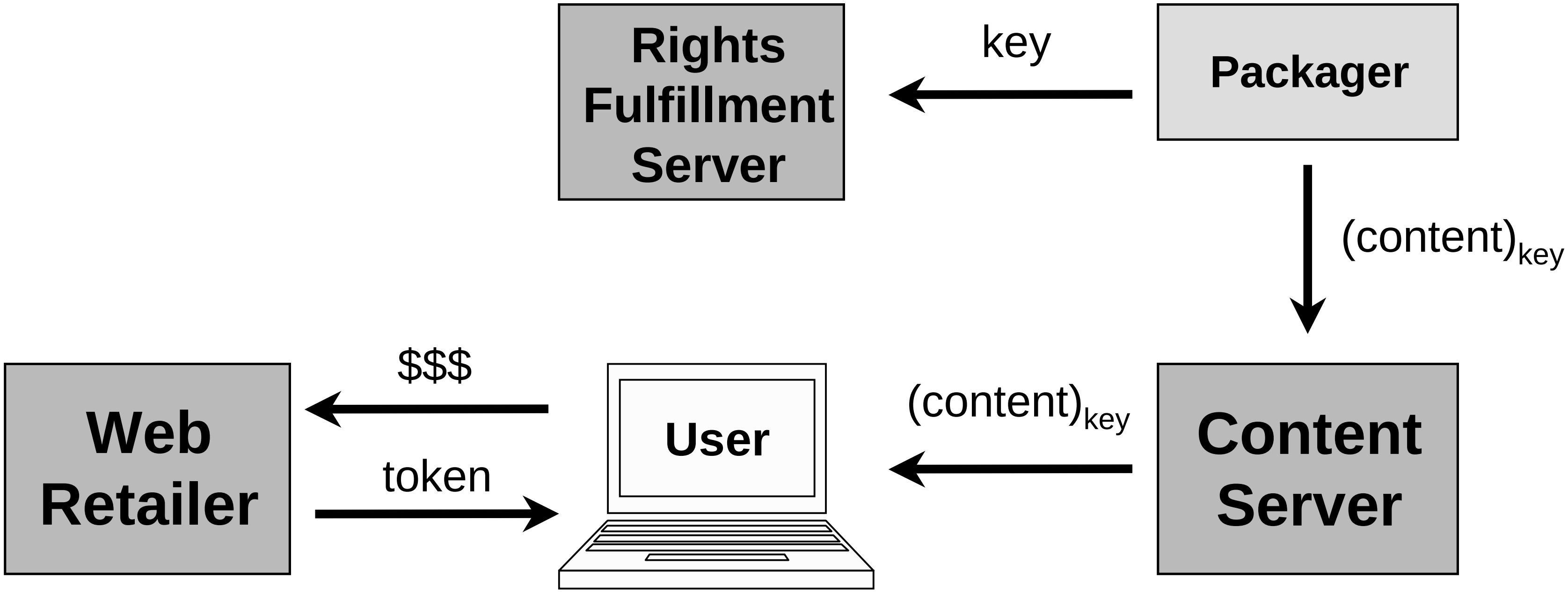
Content Server

(content)$_{key}$

User

Web Retailer

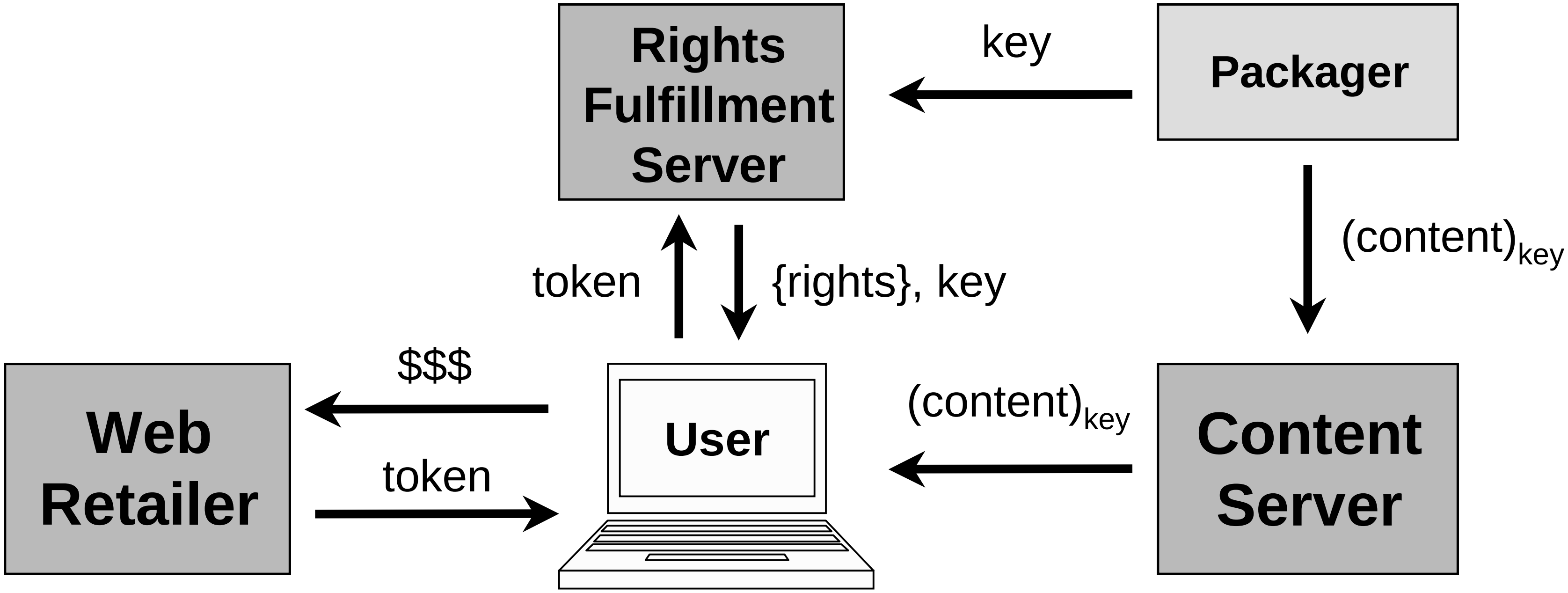
Generic DRM System



Different options for purchase:

- Pay-per-use content-specific token
- Subscription token

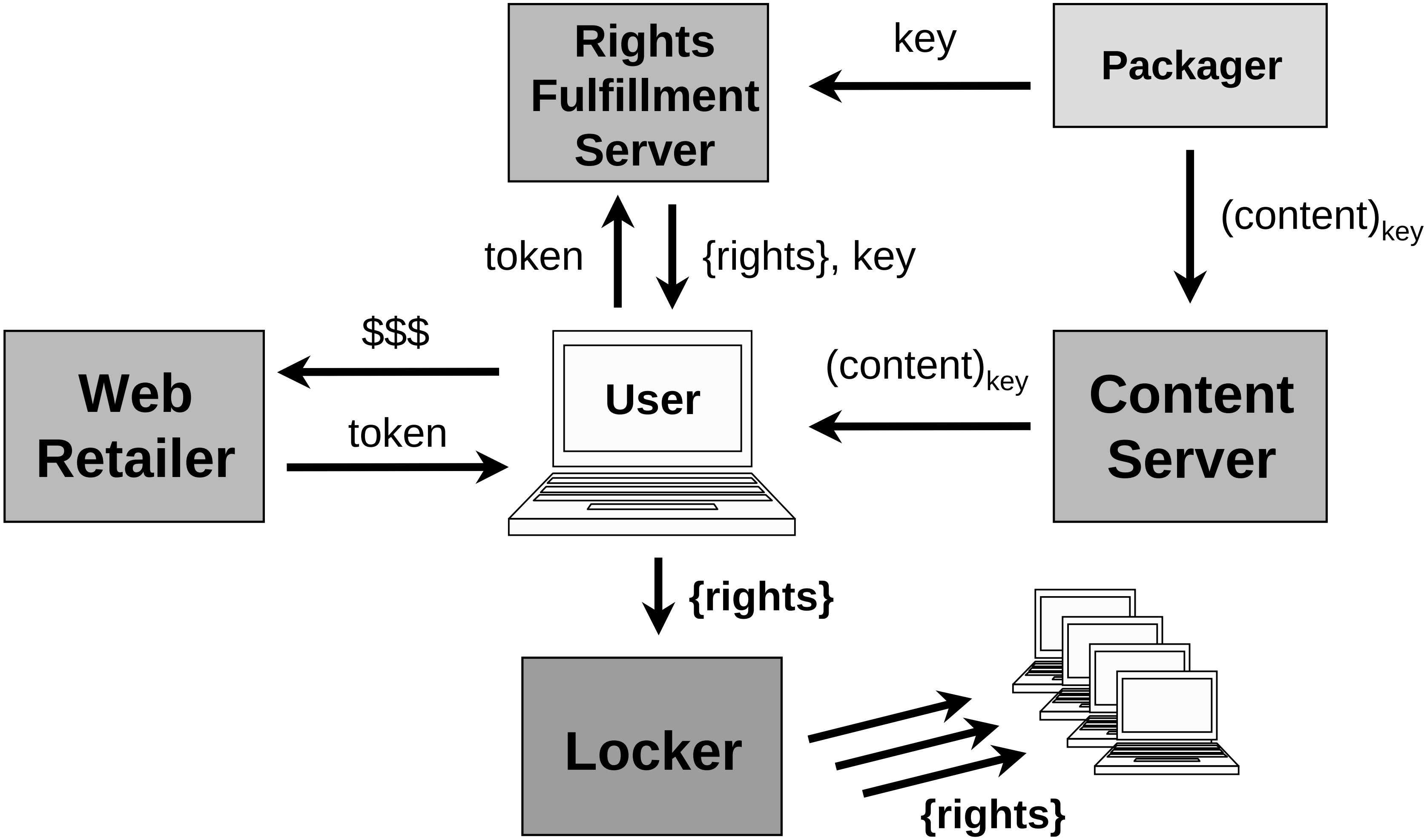
Generic DRM System



Key concept:

Separation of content and rights to access/use

Generic DRM System



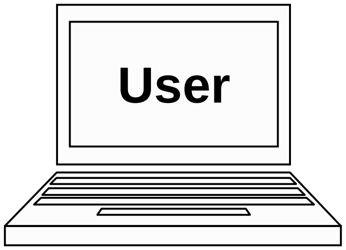
But what about privacy?

Cryptography to the rescue!

- Pay for content with anonymous ecash
- Connect to all servers via anonymous mixnets
- Authenticate with anon credentials or ZK protocols
- Download content via PIR or OT
- Use SFE when services require information

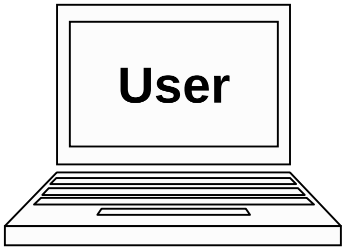
…voila!?!

Forgetful Alice…



```
alice@foo%   play ThatSongILike.mp3
Passphrase for alice@foo/1024:  ***********
Incorrect passphrase.  Try again.
Passphrase for alice@foo/1024:  ***********
Incorrect passphrase.  Try again.
```

Forgetful Alice…



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What is Alice to do?

Call customer service…
give them some information…
get a new passphrase?

But she just hid all her information from them!

The cryptographic pixie-dust fallacy

Let’s assume…

cryptography is cheap…

even secure operating systems…

Can crypto just be sprinkled throughout system?

→ Cryptographic abstractions do not adequately model “reality” and what people want to do

Mismatch of cryptographic abstractions

- Privacy-enhancing techniques typically offer:
  - Hiding of information
  - Anonymity
  - Require a clearly defined “Alice and Bob” threat model
- In “real” world:
  - Cryptographic protocols can not address “purpose binding”: How *already learned* information is used
  - Business world in flux: mergers, acquisitions, etc.
  - Know thy enemy? good guy vs. bad guy, trusted vs. untrusted, private vs. public

“Legitimate” uses for information

- Risk management: misuse and anomaly detection, revocation, fraud deterrence
- Profiling and counting, e.g., for artist compensation
- Targeted marketing and recommendation services
- Depersonalized data for trend-spotting, mining
- Customer service and retention
- Backup and archiving
- Traffic modeling for infrastructure, QoS

Asymmetry of power

- Alice = consumer
- Bob = content provider

- Crypto paradox:
  - Crypto protocol protects Alice's info from Bob
  - But against his Bob's will?

    Bob needs to agree to run it in the first place.

- Consequence:
  - Providing privacy requires Bob's buy in
  - There may be technically much-easier solutions:

    Bob may favor over complicated cryptographic protocols

Asymmetry of knowledge

- Consumers cannot measure or differentiate
  - Earthlink vs. Zero-Knowledge
- Consumers are not willing to “pay” for privacy
  - No commercially-successful privacy technology on Internet
  - Even free software (e.g., cookie blockers) not adopted
- Consequence:
  - Business-incentives to offer cryptographically-strong privacy?

Costs of privacy

- Economics argument:
  - Switch only if benefits > costs
  - Network externalities
  - Asymmetries, demand…
- Technical argument:
  - Engineering costs, system complexity grows dramatically
  - High computational costs for privacy
  - Opportunity costs for not learning the “legitimate” info

⟶ Internet businesses typically want to leverage existing infrastructure

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Practical privacy engineering

- Provocative claim:
  - – Crypto is a distraction for actually improving privacy
  - – Crypto will play important role only for simple tasks
    - SSL, authentication, etc…

- Needed: reasonable notion of privacy goals
- Needed: practical methodology for privacy engineering
  - – Low business costs
    - Provides “necessary” information
  - – Low consumer costs
    - Low latency
    - Easy to use
    - No initiative required: built into the DRM infrastructure

Goals for practical privacy engineering

- Based on Fair Information Principles (FIPs)
  - Notice
  - Choice
  - Access
  - Security
  - Enforcement
- Advantages:
  - Do not prescribe technical implementation
  - Underlie most privacy friendly legislation, e.g., Europe
  - Becoming *de facto* measure
    - good enough for businesses
    - strong for consumers

Simple privacy engineering principles

1. Collection limitation:
   - Only collect the information really needed
   - Step 1: Analyze precisely what is needed
   - Many tasks may not require PII or UID

2. Database design
   - Separation of duty: split databases
   - Easy pseudonymization
   - Data erasure, esp. for long-term storage

3. Client-side data aggregation
   - Transfer preprocessed data
   - Control info flow by granularity

Simple privacy engineering principles

4. Notice and purpose disclosure
   - What's being collected
   - How it's being used

5. Reasonable choice
   - "No privacy" vs. "No service" not sufficient

⟶ System capabilities

⟶ Language expressibility

(similar goals as P3P)

Simple privacy engineering principles

- Why would business want to follow?
  - – Adhere to privacy laws
  - – Market differentiation
  - – Costs of managing collected data
  - – Process issues dominate privacy failures

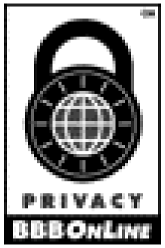
- But this is a "trust me" solution:

Cryptographer: I want math and proofs!

Audits and enforcement

Users: Math? I don’t understand math…

A seal is proof for me!



Combining notice and auditability is strong!

- Notice enforcement:

  Legally binds companies to specific practices

- Auditing process, tools:

  Verify that agreed-upon practices are enacted

Main lessons from DRM…

- DRM can be a key enabler of privacy
  - Exchange of content for money
  - Reduces the need to rely on privacy-intrusive revenue generations

- Meta Lesson

  Privacy should be part of initial design phase

Main lessons from DRM…

- Cryptography does not effectively address complex privacy concerns in DRM

- Likely similar for many "web services"

- Needed:

  1. Methodology for practical privacy engineering
  2. Catalog of best privacy practices
  3. Tools and standard components

     a. System development for notice/choice
     b. Techniques to reduce leakage
     c. Process auditing