Wissenschaftliche Bewertung von DRM-Systemen

Scientific evaluation of DRM systems

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http://www.inf.tu-dresden.de/~hf2/

- Adversary model
- Strength of existing systems
- Tendencies
- DRM technologies
- Summary

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What is the scope of the attacker?

- More general: What are the security demands?
  - confidentiality of content
  - integrity of content
  - availability of content

- Confidentiality:
  - protection against piracy
    - copy one content
    - copy every content in a certain time frame
    - break the entire system (copy every message at every time)
- Integrity:
  - authorized access to content
  - protection of ownership of content
- Availability:
  - prevention of denial of service attacks

Adversary model

- Security depends on the supposed strength of the attacker.

- Resources
  - Money
  - Time
  - Knowledge
- insider or outsider
  - concerning organizational aspects (secrecy of master encryption keys)
  - concerning design secrets (e.g. of protection functionality in hard- and software)
- Who wants to attack a system?
  - Hobbyist (naïve attacker, no financial efforts)
  - Serious attacker (intelligent, probably no financial efforts)
  - Professional attacker (intelligent, financial motivation)

The existence of specialized tools shifts the "knowledge" to anybody

Strength of existing systems

- Very limited protection
  - Most systems
    - protect against hobbyists
  - DRM systems realized in software
    - no or nearly no protection against serious attacks
  - DRM systems realized in hardware
    - weak protection against serious attacks

- In the best case:
  - Technical components of DRM systems consist of special adapted and well-known IT security functions
- Worst case:
  - Content contains proprietary DRM signals or functions without any special protection

Tendencies

- Pirates try to “reverse engineer” DRM systems
  - make them useable on other platforms (Linux, …)
  - make them independent of a certain hardware and software seller
- Pirates in the Internet shift their “activities” to services
  - peer-to-peer services
  - anonymous communication services
- Pirates may use Trojan Horses to get content illegally
  - This is a very subtle and serious thread!
- Attackers make their knowledge public as automated tools
  - Hobbyists can now do professional attacks

DRM Technologies

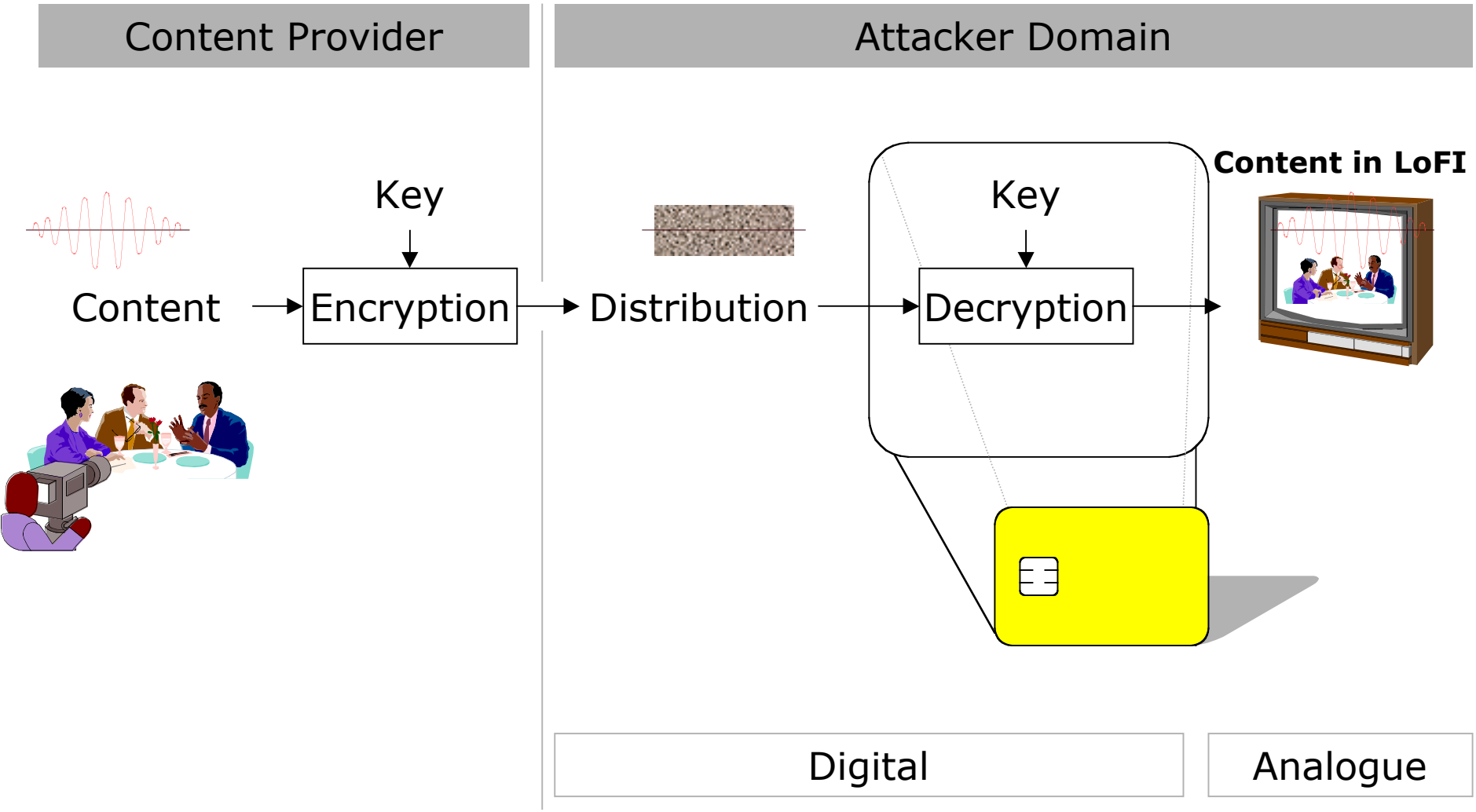
- Basic IT security technologies
  - Encryption
  - Tamper resistant hardware devices
- Special designed DRM technologies
  - Fingerprinting
  - Watermarking
- Naïve security mechanisms
  - Regional coding of content
  - Filter mechanisms
  - Incompatible formats and media
  - DRM codes without any protections against removing
  - ...

content detection

copy protection

Design Options for Copy Protection

⌘ Protect pay-services from unauthorized access



Design Options for Copy Protection

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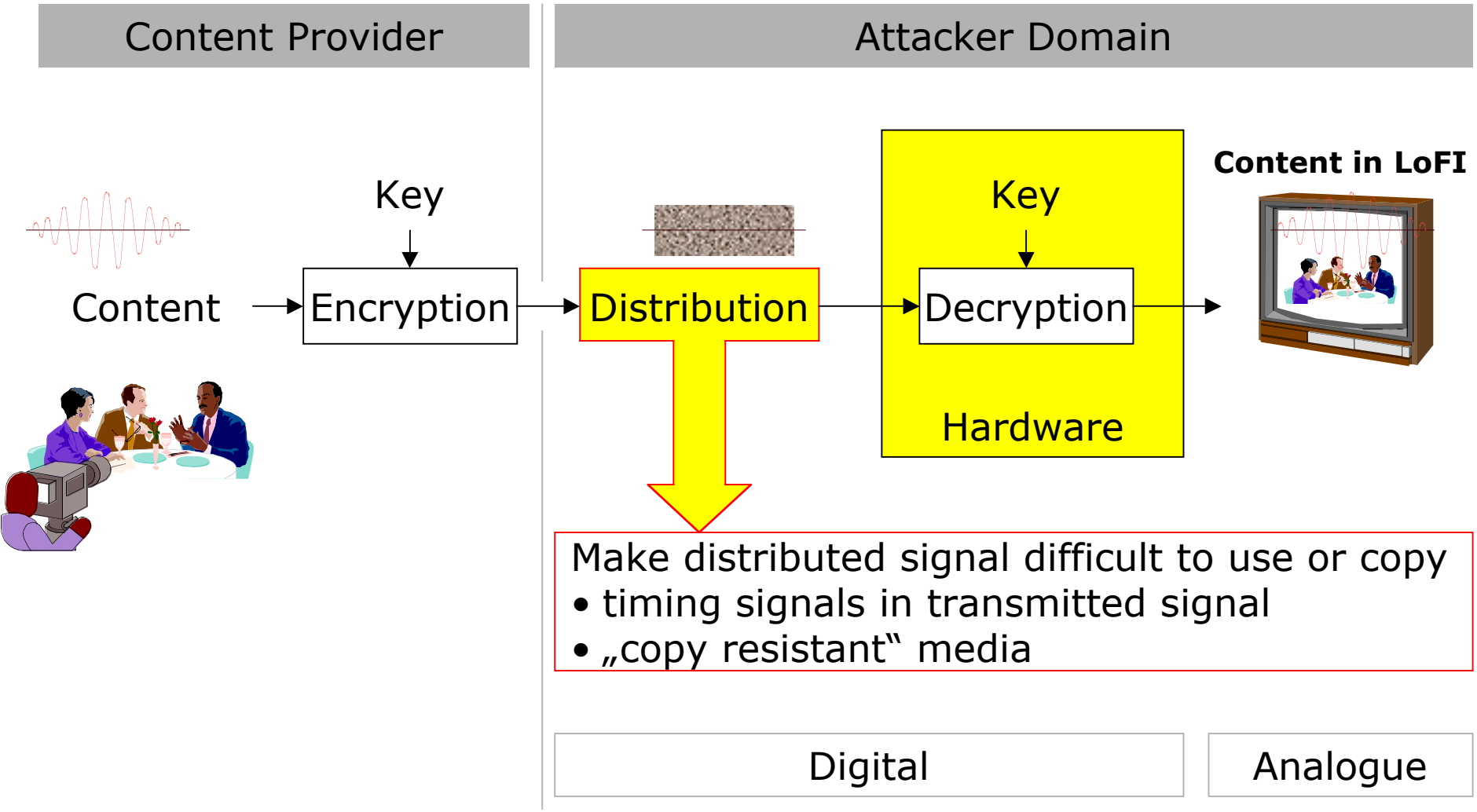
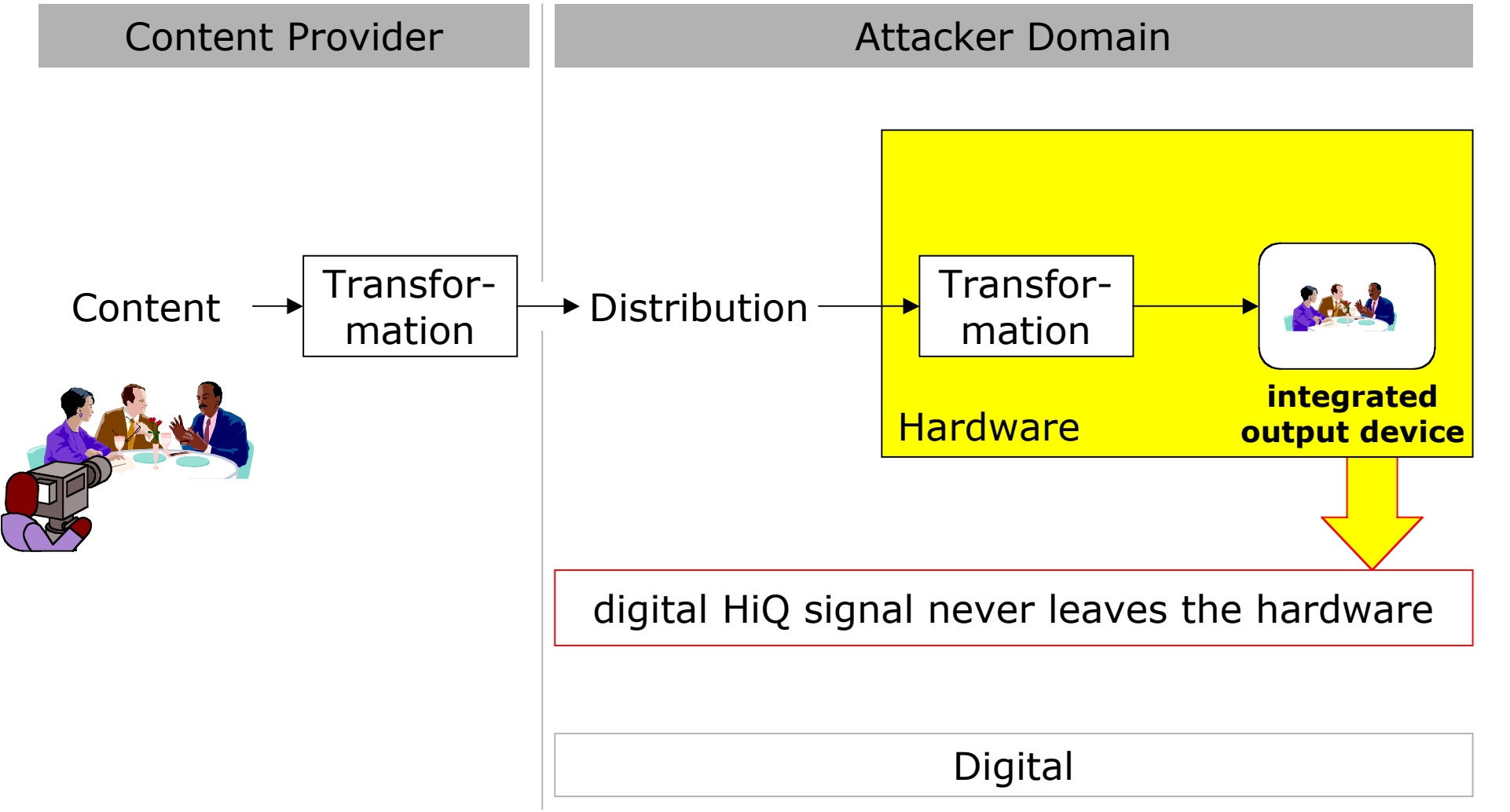
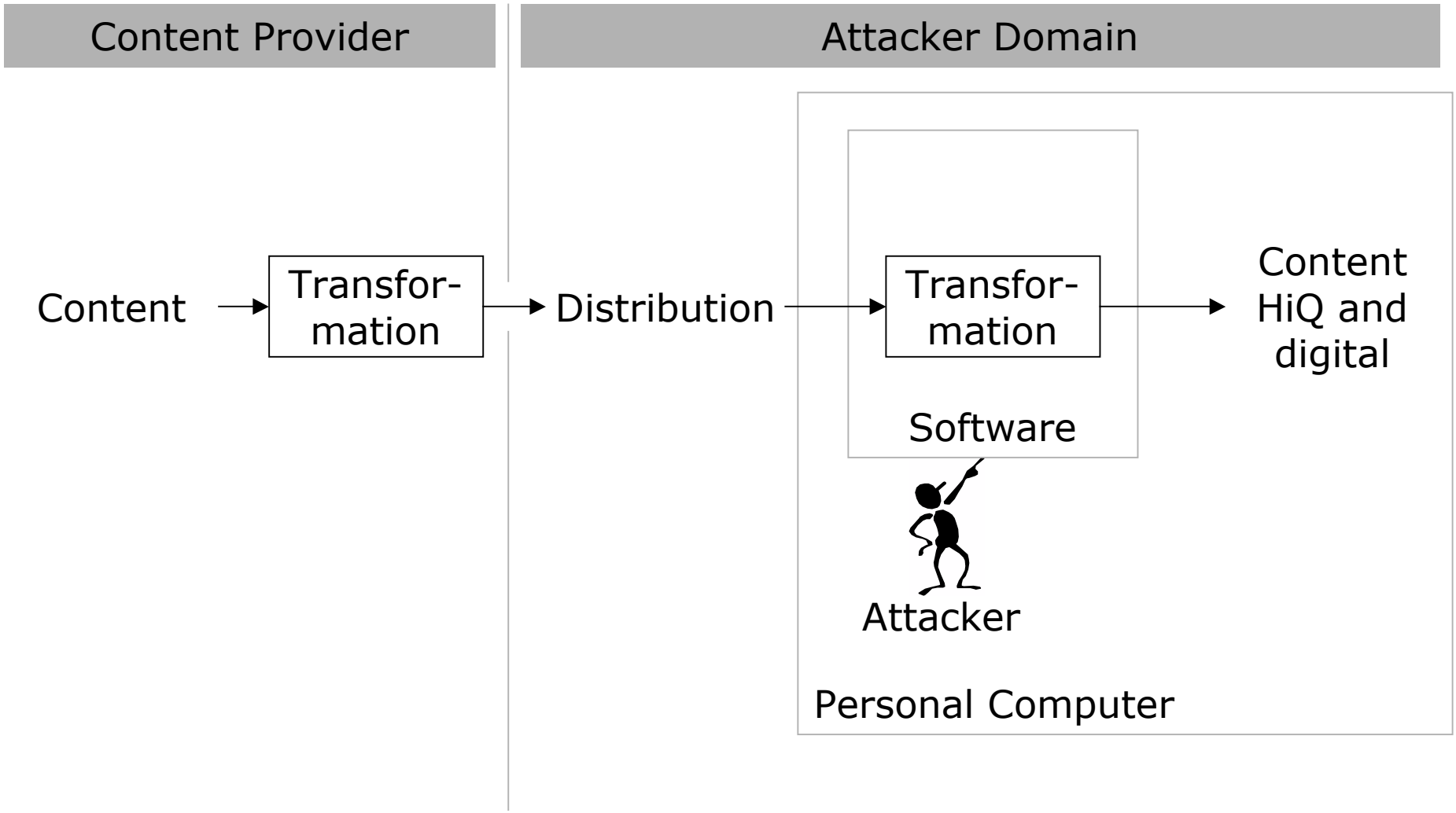


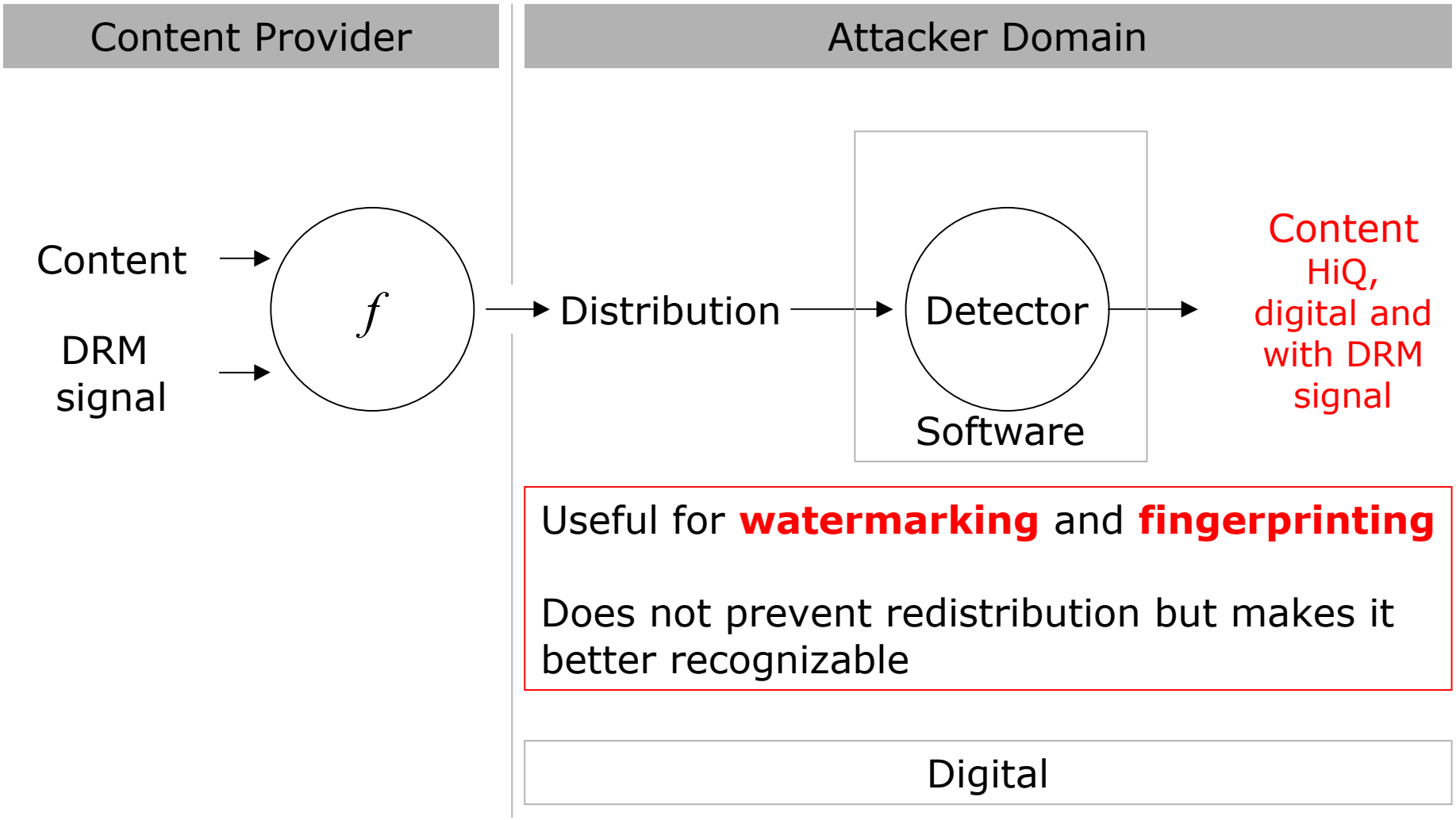
Design Options for Copy Protection



Never! Too dangerous!



What is possible in software?



What is possible in software?

Content Provider	Attacker Domain

Attention!

Scope is changing!

Not: Protection against illegal copying

But: **Detection** of copies

Cont

DRM
sign

Content
HiQ,
igital and
with DRM
signal

printing

Does not prevent redistribution but makes it better recognizable

Digital

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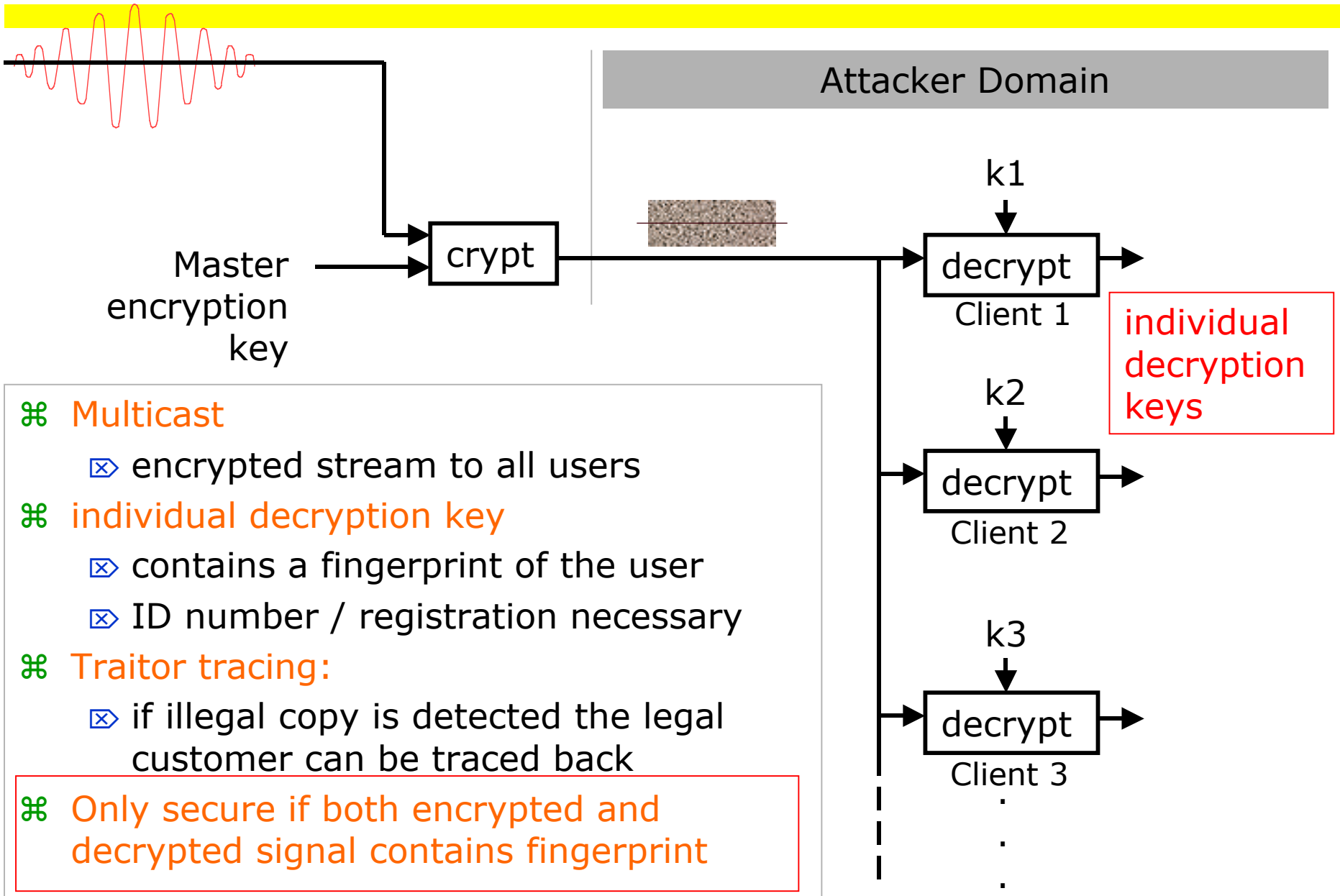
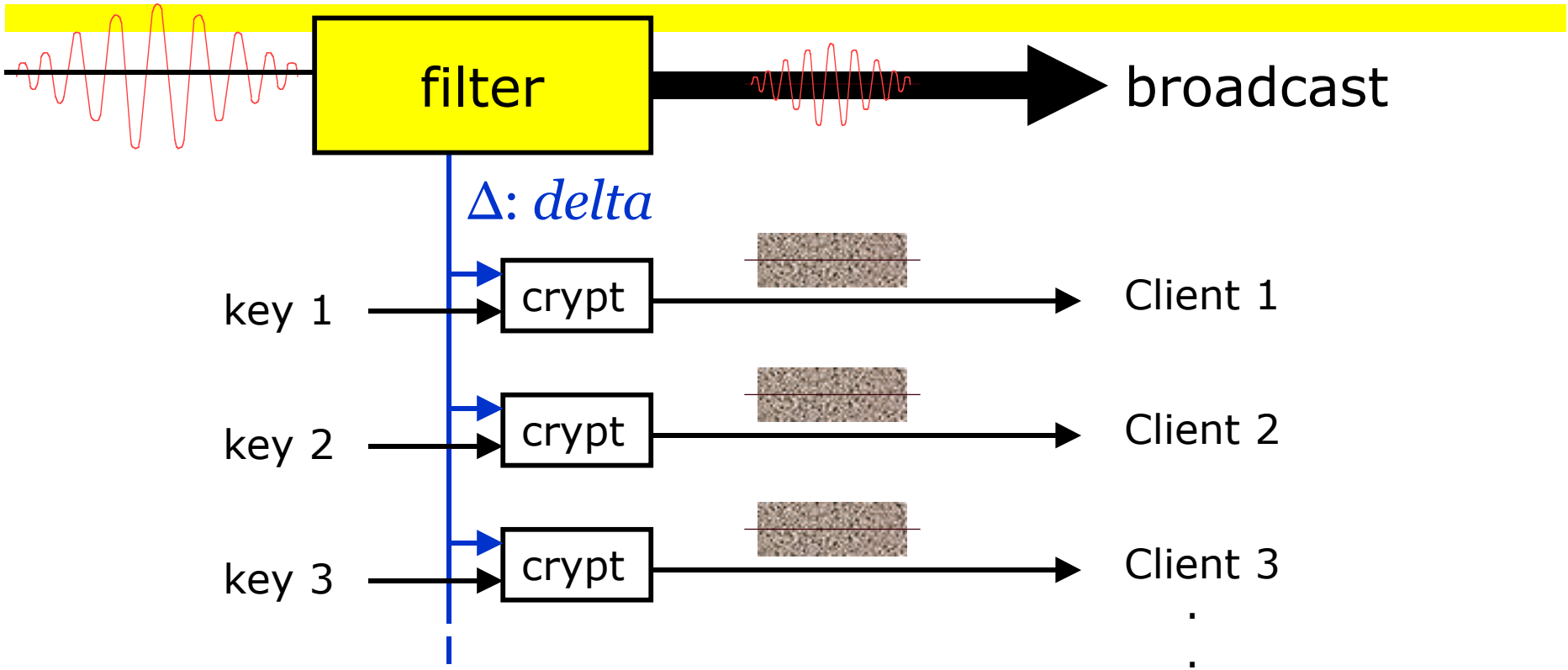
content detection

Broadcast encryption



- Multicast
  - encrypted stream to all users
- individual decryption key
  - contains a fingerprint of the user
  - ID number / registration necessary
- Traitor tracing:
  - if illegal copy is detected the legal customer can be traced back
- Only secure if both encrypted and decrypted signal contains fingerprint

> LoFi Broadcast, HiFi Encryption



- Divide stream into quality layers
  - Everybody gets the low quality layer
  - Paying customers get encrypted layers
- MP3:
  - division of mp3 stream into quality layers
- costs are linear in the number of users

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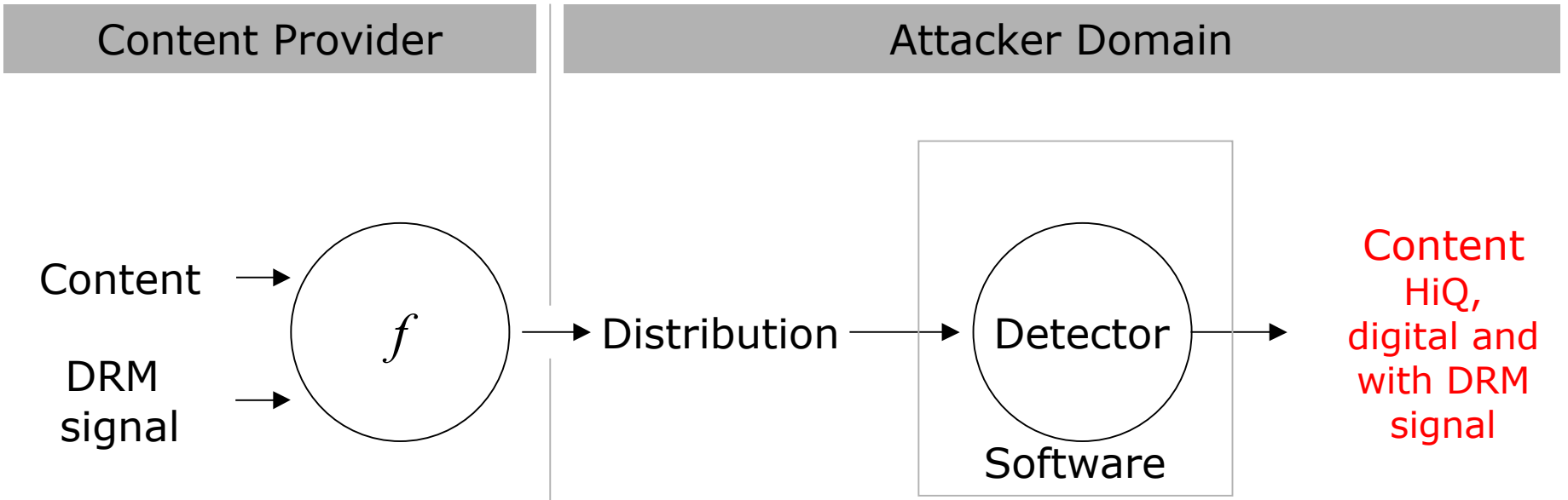
content detection

Watermarking



- Watermarking:
  - Goal: Protection of authorship
  - Not: Protection against illegal copying
  - Possible: Detection of copies

Digital

Watermarking

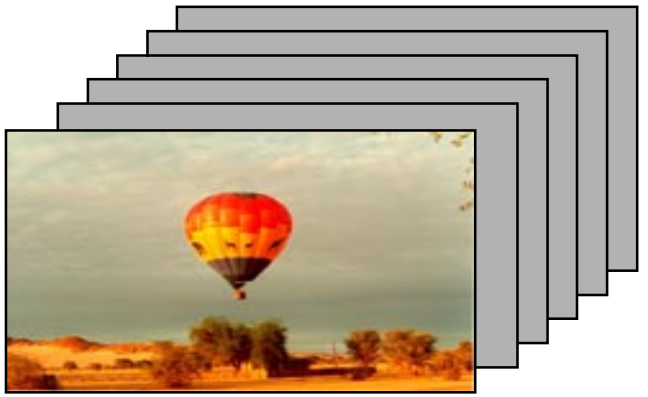
- Scope: Protect authorship of digital content
- correlation necessary
- few 100 bit
- strong changes

Original

Key

Embedding

Distribution



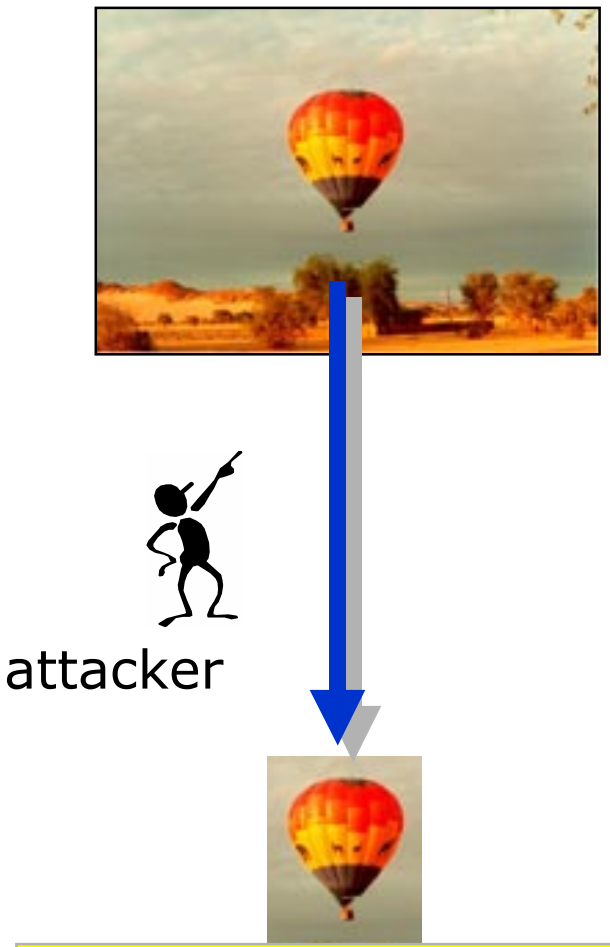
Attacker

Watermark Signal:

Copyright (C) 1998
Document-ID: #A53-229D789
Author: J.Fitzgerald
Title: White Christmas

- ⌘ Digital-Analogue-Conversion
- ⌘ Analogue-Digital-Conversion
- ⌘ Re-Sampling
- ⌘ Re-Quantization
- ⌘ Compression
- ⌘ Dithering
- ⌘ Rotation
- ⌘ Translation
- ⌘ Cropping
- ⌘ Scaling

- ⌘ Collusion Attacks



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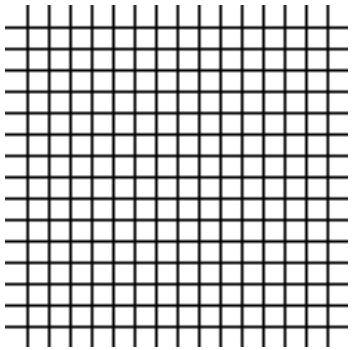
> Security of watermarking systems

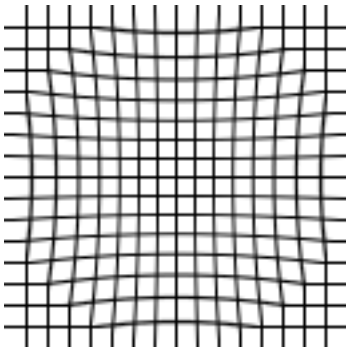
- Theory
  - robustness
  - non-interference
  - detectability

- Praxis: (attacks by M. Kuhn, F. Petitcolas, 1997)
  - StirMark
    - Software
    - removes watermarks
    - watermark is no longer detectable
    - http://www.cl.cam.ac.uk/~fapp2/watermarking/stirmark/
  - Mosaic Attack
    - divides web images into a mosaic of tabular cells
    - browser reconstructs the view of the image

Stirmark Attack

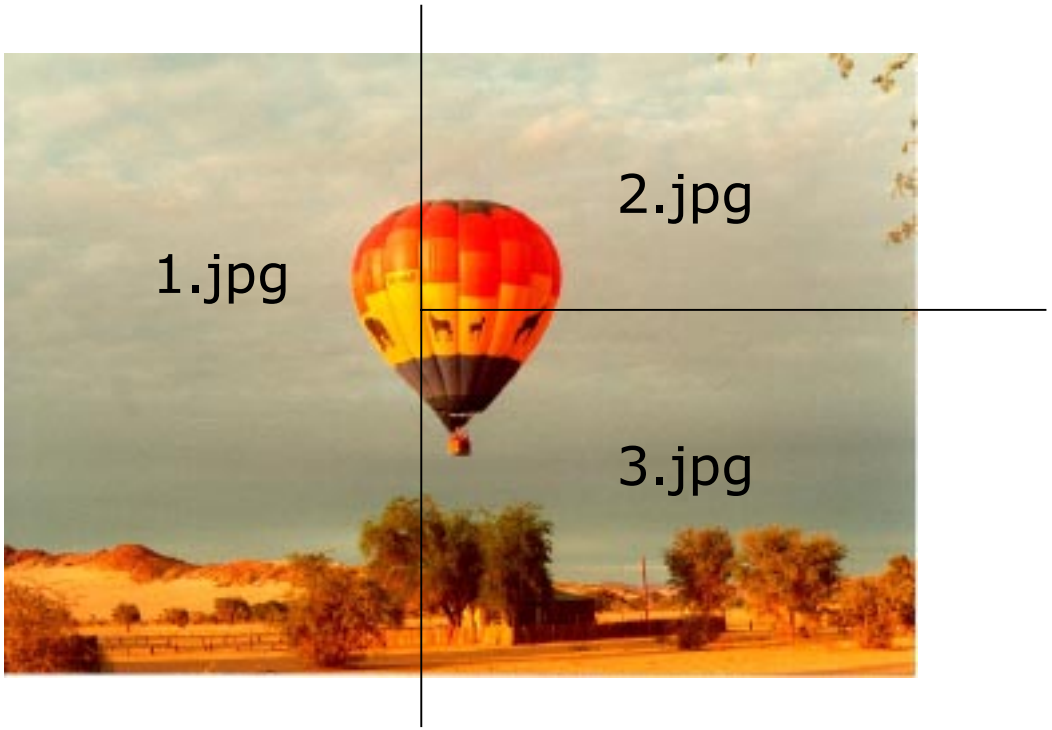
- non-linear transformation of a picture
- synchronization gets lost
- no anchor for detector to find the position of embedded signal





Mosaic Attack

- divides web images into a mosaic of tabular cells
- uses html statements
- browser reconstructs the view of the image
- protects from very simple web robots that look for illegally distributed material



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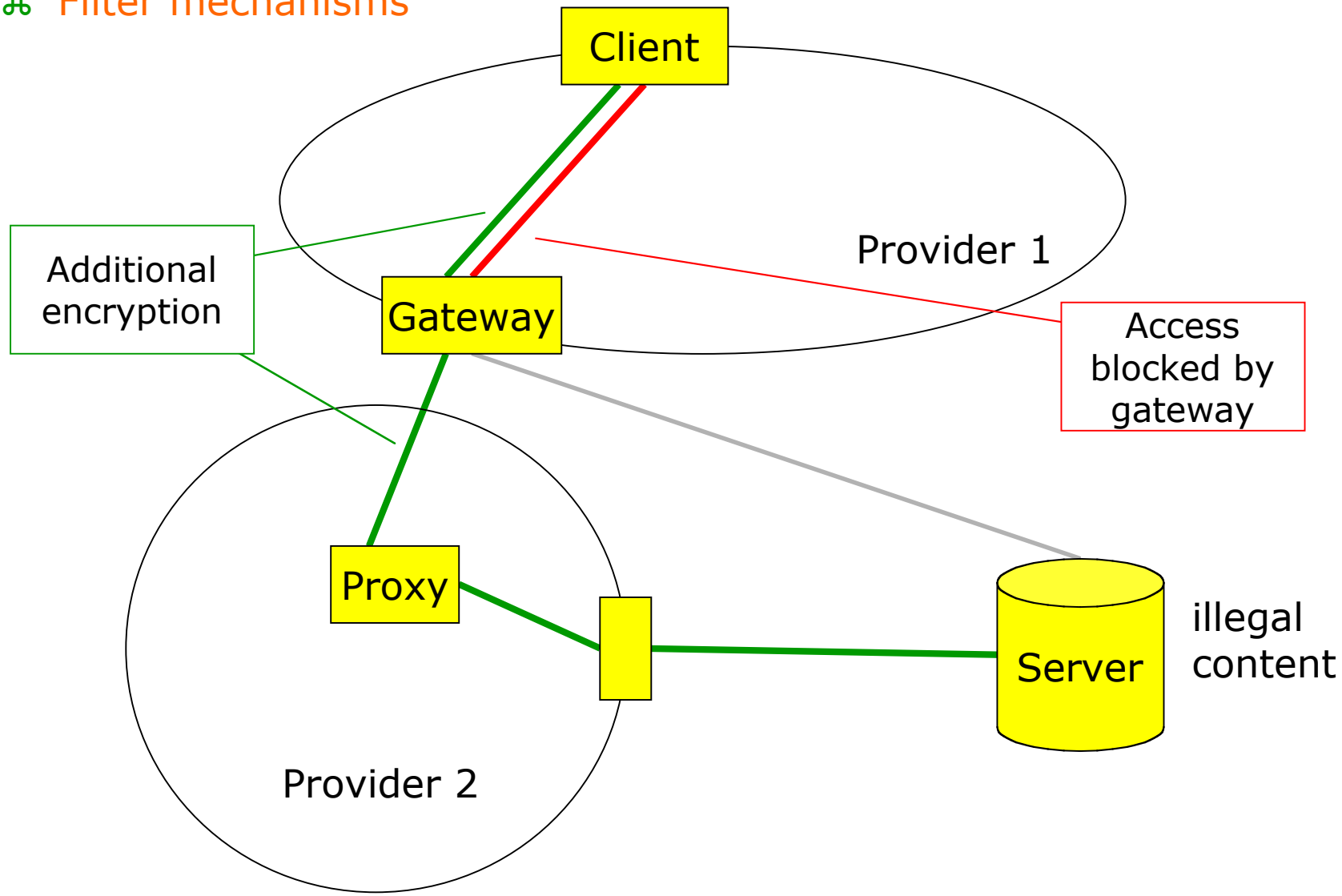
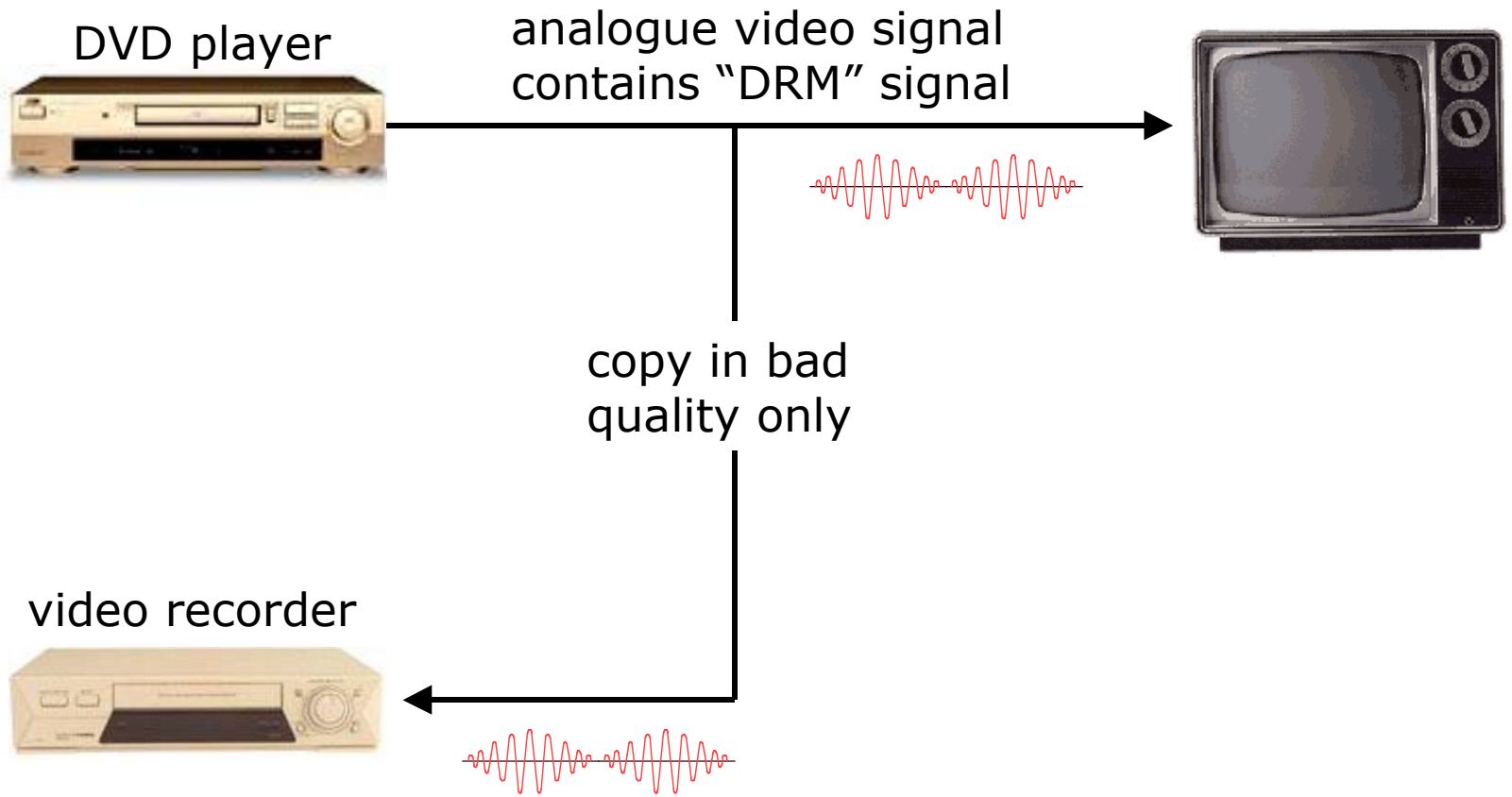
Naïve security mechanisms – examples

⌘ Filter mechanisms



Naïve security mechanisms – examples

- copy protection in videos recorders



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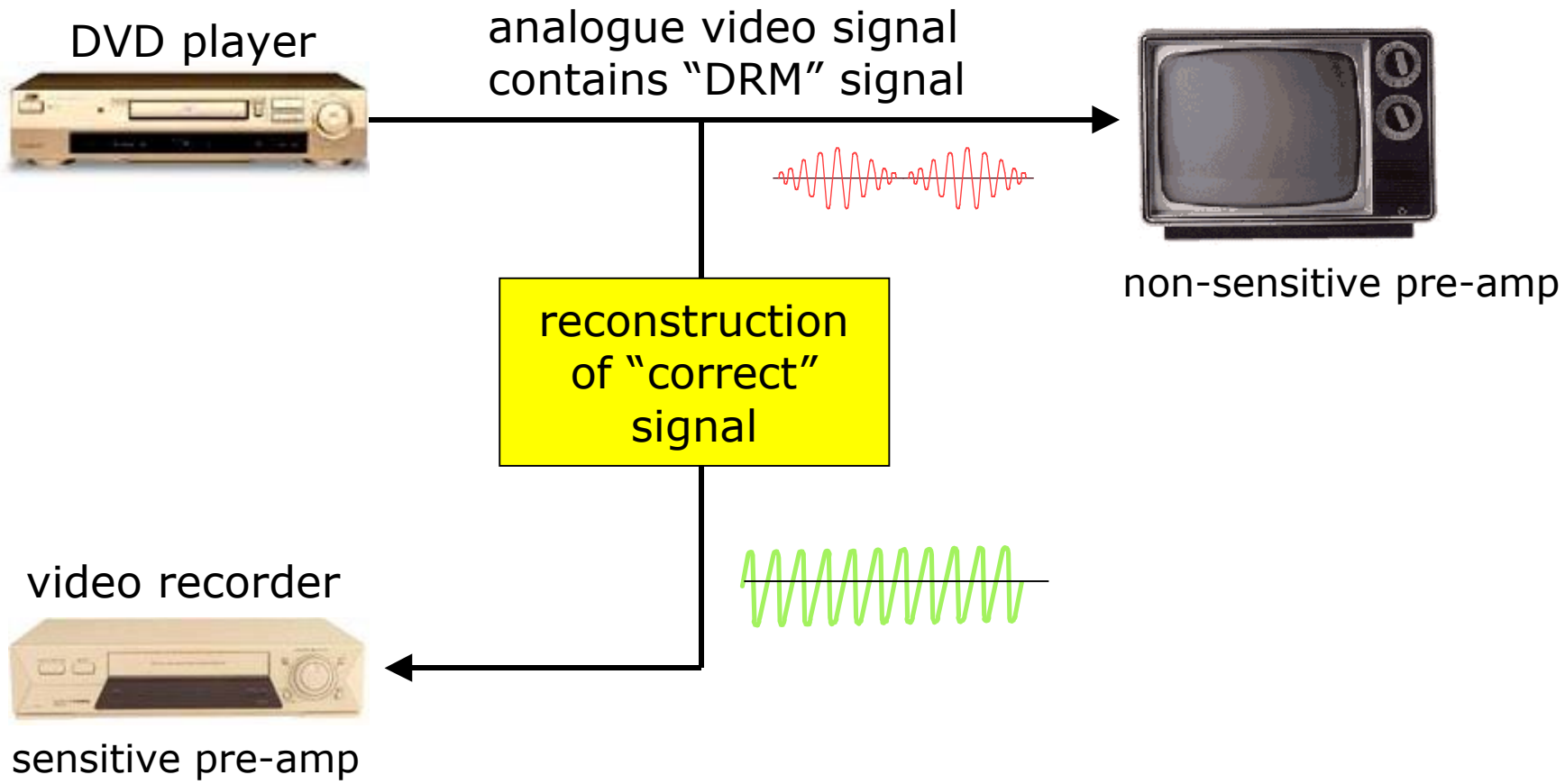


Naïve security mechanisms – examples

- DRM codes without any protections against removing

digital audio player

digital audio

digital recorder

MD, CD-R (Audio), DAT

Original: copy bit unset

0100101011101011101010011100110010

Copy: content with copy bit set

0100111011111011111010110111011100 11

Naïve security mechanisms – examples

⌘ DRM codes without any protections against removing

digital audio player

digital audio

digital recorder

MD, CD-R (Audio), DAT

Original 0100101011101011101010011100110010

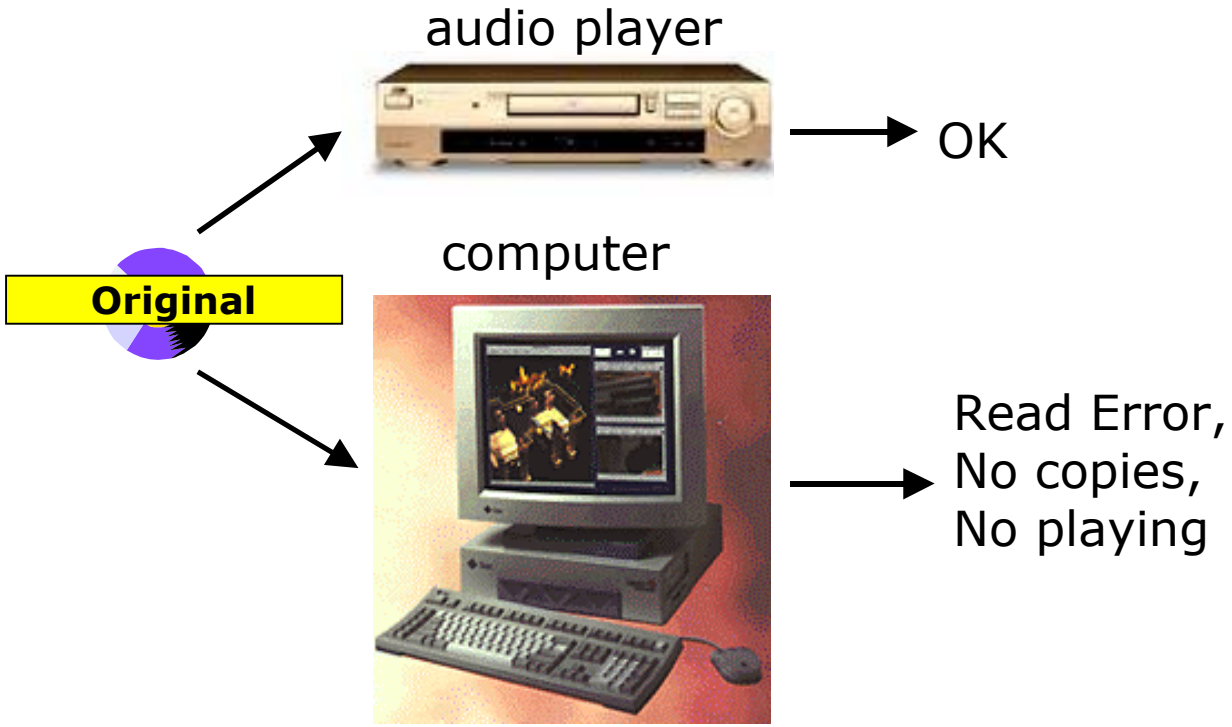
Copy 0100111011111011111010110111011100 11

Reset copy bit to make copies

Copy 010011101111 [ ] 010010101110 !

Naïve security mechanisms – examples

- incompatible formats and media



Naïve security mechanisms – examples

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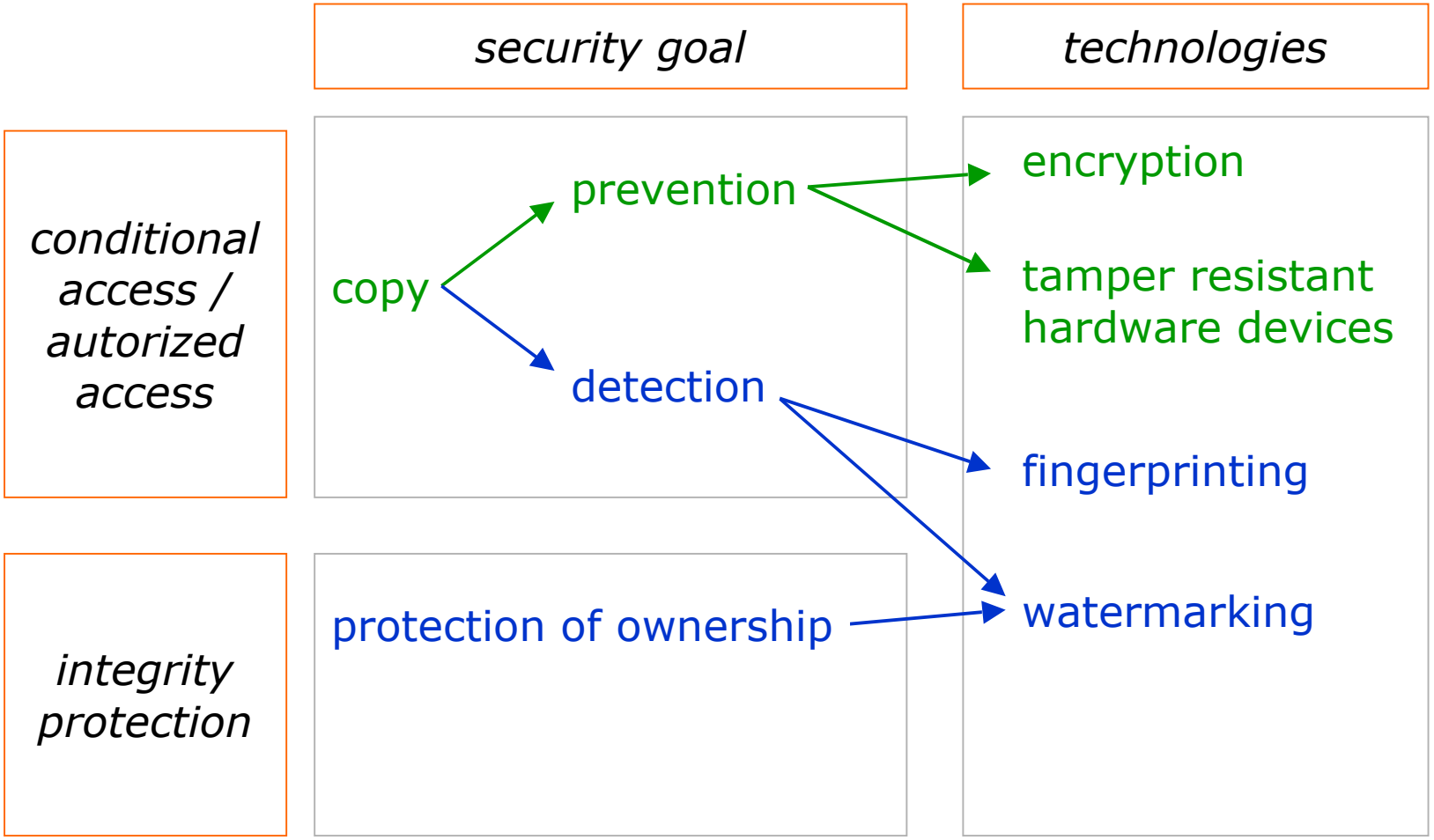
Basic security goals and corresponding technologies



Secure DRM systems

- Secure DRM systems connect a DRM signal with the content to protect in a way that the content signal is useless without the DRM signal.

- Options:
  - DRM signal is part of the content signal (e.g. in watermarking systems)
  - DRM signal is necessary to access/decrypt the encrypted content signal
- Important point:
  - Detection of DRM signal cannot be bypassed
  - Hardware or software encapsulation

- Software
  - not recommendable
- Hardware
  - breaking is a matter of time and money