Multimedia im Netz
Online Multimedia

Wintersemester 2014/2015

Part II

Content-Oriented Base Technologies for Networked Multimedia

Outline

* = Nicht für Nebenfach !

1. Introduction and Motivation

Part I: Web Technologies for Interactive MM

2. Interactive Web Applications
3. Web Paradigms and Interactivity *
4. Technology Evolution for Web Applications *
5. Communities, the Web, and Multimedia

Part II: Content-Oriented Base Technologies

6. Digital Rights - Definition and Management
7. Cryptographic Techniques
8. Multimedia Content Description

Part III: Multimedia Distribution Services

9. Electronic Books and Magazines
10. Multimedia Content Production and Management
11. Streaming Architectures
12. Web Radio, Web TV and IPTV

Part IV: Conversational Multimedia Services

13. Multimedia Conferencing
14. Signaling Protocols for Multimedia Communication *

15. Visions and Outlook

6 Digital Rights – Definition and Management

Literature:

Bill Rosenblatt, Bill Trippe, Stephen Mooney: Digital Rights Management – Business and Technology, M&T Books 2002

Ronan Deazley, Martin Kretschmer, Lionel Bently (eds): Privilege and property: Essays on the history of copyright, Open Book Publishers 2010

Copyright / Intellectual Property Right (IPR)

- History:
  - "Intellectual property" unknown in ancient and medieval cultures
  - "Author privileges" (since 1486, Venice) (book printing since 1440)
  - Theory of intellectual property since approx. 1700
- Functions of copyright:
  - Securing rights for the author of a work to use it, publish it, benefit financially from it and to control its use
  - Copyright is established directly, independent of registration
    - » Differently as with other forms of IPR (patents, trade marks)
- Principle of territoriality
  - Regional laws
  - Few international treaties
    - » WIPO = World Intellectual Property Organisation (www.wipo.int)
    - » 150 participating countries

Koalitionsvertrag 2013: *„Zum effektiveren Schutz von Markeninhabern, Urhebern und anderen Kreativen vor Rechtsverletzungen im weltweiten digitalen Netz streben wir den Ausbau verbindlicher europäischer und internationaler Vereinbarungen an."*

www.copyrighthistory.org

Types of Copyrighted Works

- Literary works, e.g. newspapers, manuals, fiction, non-fiction, poetry, advertisements, ...
- Musical works, such as songs and instrumentals
- Dramatic works, such as plays
- Pantomime and choreographic works, such as dance and mime
- Pictorial, graphic and sculptural works, such as photographs, paintings, maps, drawings, ...
- Motion pictures and other audiovisual works
- Sound recordings
- Architectural works
- Audio-visual displays
- Software programs

Copyright + Internet = Many Open Questions!

Aus diesen Gründen hat der Gerichtshof (Neunte Kammer) für Recht erkannt:

It hence decided that:

'… the embedding of a protected work which is publicly accessible on a website in another website by means of a link and using the framing technology, as was the subject of the main proceedings, by itself does not constitute communication to the public within the meaning of Article 3 (1) of Directive 2001/29 to the extent that the relevant work is neither communicated to a new public nor is it communicated using a specific technical means which is different from that of the original communication. (…) **If and to the extent that this work is freely accessible on the website to which the internet link points, the assumption must be made that the holders of the copyright have, when they permitted this communication, considered all internet users as the public**.'

[UNOFFICIAL TRANSLATION - emphasis added]

http://copyright4creativity.eu

ursprünglichen Wiedergabe unterscheidet.

Luxemburg, den 21. Oktober 2014

Court of Justice of the EU
(PDF available at http://www.new-media-law.net/)

IPR in the U.S. (1)

- Article 1, section 8 of U.S. Constitution:
  - "The Congress shall have Power […] to promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."
- Copyright Act of U.S. Congress 1976
  - Protects "…original works of authorship fixed in a tangible medium of expression, now known or later developed, from which they can be perceived, reproduced and otherwise communicated, either directly or with the aid of a machine or device"
  - ***Fair-Use*** Doctrine

    Use of the copyrighted work to a small extent which does not affect the market value of the work is admitted
  - ***First-Sale*** Doctrine

    Buyers get extensive rights to do everything they want with the physical copy bought, but they do not get the copyright for the content
  - ***Public-Domain*** Doctrine

    Works older than 70 years are free of copyright

IPR in the U.S. (2)

- Digital Millennium Copyright Act (DMCA) 1998
  - US response to world-wide copyright treaties (*WIPO Copyright Treaty* and *WIPO Performances and Phonograms Treaty*)
  - Section 1201: ***Anti-circumvention provision:***

    It is prohibited to make or sell devices that
    - » Are primarily designed or produced to circumvent technological measures to protect copyrights
    - » Have only limited commercial significant purpose or use other than this kind of circumvention
    - » Are marketed for such circumvention
  - Tacit admission that copy-protection technologies will never be perfect!
  - Problematic:
    - » Where does fair use end? (e.g. circumvention for backup copies)
    - » Can DMCA restrict the right of free speech? (e.g. for magazines publicizing protection-cracking software code)
  - “Exemptions” approved in 2000, 2003, 2006, and 2010

IPR in the EU

- Original Idea: Harmonization of the individual regulations of the EU member states
  - "Green Book" 1997
- Basis: Article 94 of EU Treaty
  - "Harmonization of national provisions affecting Common Market"
- EU entered WIPO in 2001
- EU Copyright Directive (Info-Richtlinie) 2001
  - Gives a similar basis for Digital Rights Management as the DMCA in the U.S.A.
  - Strong emphasis on the rights of the creator *(droit moral),* less market-oriented

Urheberrecht in Germany

- Urheberrechtsgesetz (UrhG) 1965
  - http://www.gesetze-im-internet.de/englisch_urhg/englisch_urhg.html
- Update 2003 (“Erster Korb”) to align with EU Copyright Directive and WIPO treaty
  - Intellectual and personal relationship of the creator to his work
    – ***only for natural persons*** (in contrast to US: valid for all legal entities)
  - Incentive for creator to further produce
  - Guarantee for adequate remuneration
  - Ownership of creator is almost as strong as for tangible objects
- Two kinds of rights:
  - Author's copyright protection
    - » Authorship is non-transferable (cannot be sold, given away, inherited)
  - Exploitation rights
    - » Author can grant rights for reproduction and distribution of his work
    - » Reproduction for private use (Privatkopie) allowed in §53 – restricted by §95a ("technological measures may not be circumvented")

Evolution of German Authors' Rights Legislation

Further reform of UrhG 2008 („Zweiter Korb“):

- Copies for private use and exchange:
  - Circumvention of copy-protection forbidden, also for personal use (§95a)
  - File sharing of copyrighted material forbidden (§53 updated)
    [permitted to make copies] "as long as no obviously unlawfully-produced model or a model which has been unlawfully made available to the public is used for copying"
  - Remuneration to authors for copies for private use (through fees collected from manufacturers or reproduction appliances and storage media)
  - No exceptions for cases of minor severity (§106)
    "shall be liable to imprisonment of not more than 3 years or a fine"
- Public availability for instruction and research:
  - Special rules in §52a, valid only until end of 2014 (§137k)
  - §52b: Digital library contents may be made available "exclusively on the premises of the relevant institution at terminals dedicated to the purpose of research and for private study"

Koalitionsvertrag 2013: *„Wir werden eine Reform des Urheberrechts auf den Weg bringen mit dem Ziel, den wichtigen Belangen von Wissenschaft, Forschung und Bildung stärker Rechnung zu tragen und eine Bildungs- und Wissenschaftsschranke einführen. Wir werden prüfen, ob den öffentlichen Bibliotheken gesetzlich das Recht eingeräumt werden sollte, elektronische Bücher zu lizensieren.” (S. 30)*

www.gesetze-im-internet.de/urhg

Current Topics in Copyright Legislation 2013/2014

- Special rules for instruction and research:
  - §52a highly likely to be made a permanent rule soon
  - Draft law by CDU/CSU and SPD, September 23, 2014
- “Open Access”, “Open Data”:
  - Zitate Koalitionsvertrag:
  - „Wir werden eine umfassende Open Access Strategie entwickeln, die die Rahmenbedingungen für einen effektiven und dauerhaften Zugang zu öffentlich finanzierten Publikationen und auch zu Daten (open data) verbessert.”
  - „Wir wollen für Bund, Länder und Kommunen ein Open-Data-Portal bereitstellen.”
- “Verwaiste Werke” *(unclaimed works)*

Rights Management Terminology

- *Rightsholder:* A party owning rights in intellectual property
- *User:* A party that intends to make us of intellectual property rights. May be a *licensee* or a *buyer* (or *grantee*).
- *Content owner:* Like rightsholder, but less strict. May own the rights only partially, e.g. only for specific countries.
- *Rights transaction:* Transaction establishing a new rights situation
  - Examples: Buying a newspaper, buying the right to re-publish content from the newspaper, buying the publishing house
- *Royalties:* Monetary compensation to a rightsholder or his agent for the use of intellectual property rights
- *Rights management:* Business processes that for legal and commercial purposes track rights, rightsholders, licenses, sales, royalties, and associated terms and conditions
- *Digital rights management (DRM):* Rights management using digital technology

Traditional Rights Management Solutions (1)

- Solution used for photocopying: *Copyright Clearance Center*
  - Obtains the rights from publishers to make photocopies
    - » US: Copyright Clearance Center (CCC), www.copyright.com
    - » International Federation of Reproduction Rights Organizations (IFRRO)
  - Bundles publisher rights into an offer to users like copy centers
  - Corporate organizations charged according to survey data
  - Individual “Pay-per-use” via Internet
- Rather successful, low overhead
- Germany: VG WORT (Verwertungsgemeinschaft Wort, www.vgwort.de)
  - Income is changing over time due to disputes with other organizations

    2010: € 131 M, 2011: € 120 M, 2012: € 115 M, 2013: € 129 M distributed to over 170.000 receivers
  - System works well for photocopies, extension to audiovisual media is problematic
  - German representative in the "Google Books settlement" law case

Traditional Rights Management Solutions (2)

- Voluntary collective music licensing
- Organizations for collecting fees from commercial music use
  - U.S.:
    American Society of Composers, Authors and Publishers
    (ASCAP, www.ascap.com),
    Broadcast Music International
    (BMI, www.bmi.com),
    SoundExchange (www.soundexchange.com)
    since 2000, for digital performance
  - Germany:
    “Gesellschaft für musikalische Aufführungs- und mechanische Vervielfältigungsrechte” (GEMA, www.gema.de)
- Commercially played music:
  - Radio broadcasting, concerts, restaurants, shops, hold music for phone calls, ...
  - Fees collected per actual usage

Traditional Rights Management Solutions (3)

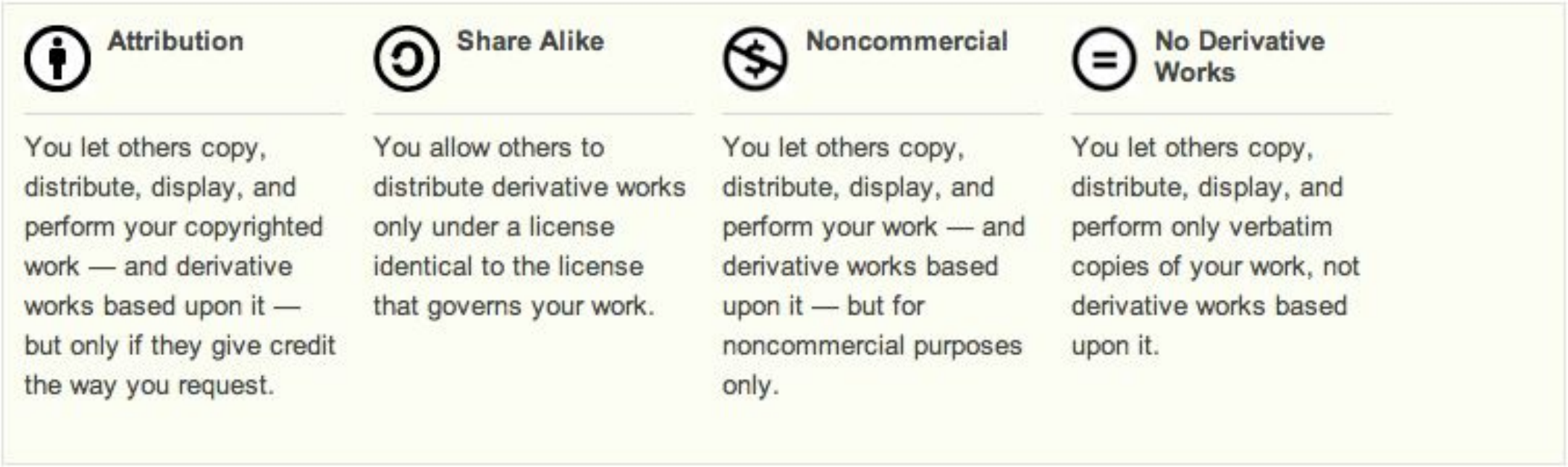
- *Compulsory licensing:*
  - Government-regulated pricing
  - Mainly for patents which are relevant for the society welfare
    - » “Clean air” technologies
    - » Unique pharamaceutical products
    - » Rarely applied to media (e.g. for National Public Radio in US)

Public Domain

- Complete refrainment from copyright-based usage restrictions
  - Enables free collaboration and "remixing" of content and knowledge
- Some content is in the public domain automatically:
  - National anthems, traditional songs, ...
  - Content the last creator of which has died 50/70/75 years ago
- Various initiatives:
  - Projekt Gutenberg (gutenberg.org): Free electronic books
  - Wikibooks
  - See publicdomainworks.net
- Various legal formulations:
  - Open Content License
  - Free Art License
  - Free Music Public License
  - Open Publication License
  - GNU Free Documentation License

Some Rights Reserved: Creative Commons

- Web culture requires new forms of copyright rules
  - Keep the copyright but allow certain uses by others
- Creative Commons (CC):
  - Non-profit organization offering "legal tools"
  - Spectrum of possibilities between public domain and full copyright
- License Conditions identified by CC:



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Attribution

Attribution Share-Alike

Attribution No Derivatives

Attribution Non-Commercial

Attribution Non-Commercial Share Alike

Attribution Non-Commercial No Derivatives
("Free advertising")

Position of the Music Industry

2002:

WASHINGTON-The Recording Industry Association of America (RIAA) announced today that the number of units shipped domestically from record companies to retail outlets and special markets (music clubs and mail order) fell 10.3 percent in 2001.

Specifically, total U.S. shipments dropped from 1.08 billion units shipped in 2000 to 968.58 million in 2001-a 10.3 percent decrease. The dollar value of all music product shipments decreased from $14.3 billion in 2000 to $13.7 billion in 2001-a 4.1 percent decrease, according to figures released today by the RIAA.

"This past year was a difficult year in the recording industry, and there is no simple explanation for the decrease in sales. The economy was slow and 9/11 interrupted the fourth quarter plans, but, a large factor contributing to the decrease in overall shipments last year is online piracy and CD-burning," said Hilary Rosen, President and CEO of the RIAA. "When 23 percent of surveyed music consumers say they are not buying more music because they are downloading or copying their music for free, we cannot ignore the impact on the marketplace."

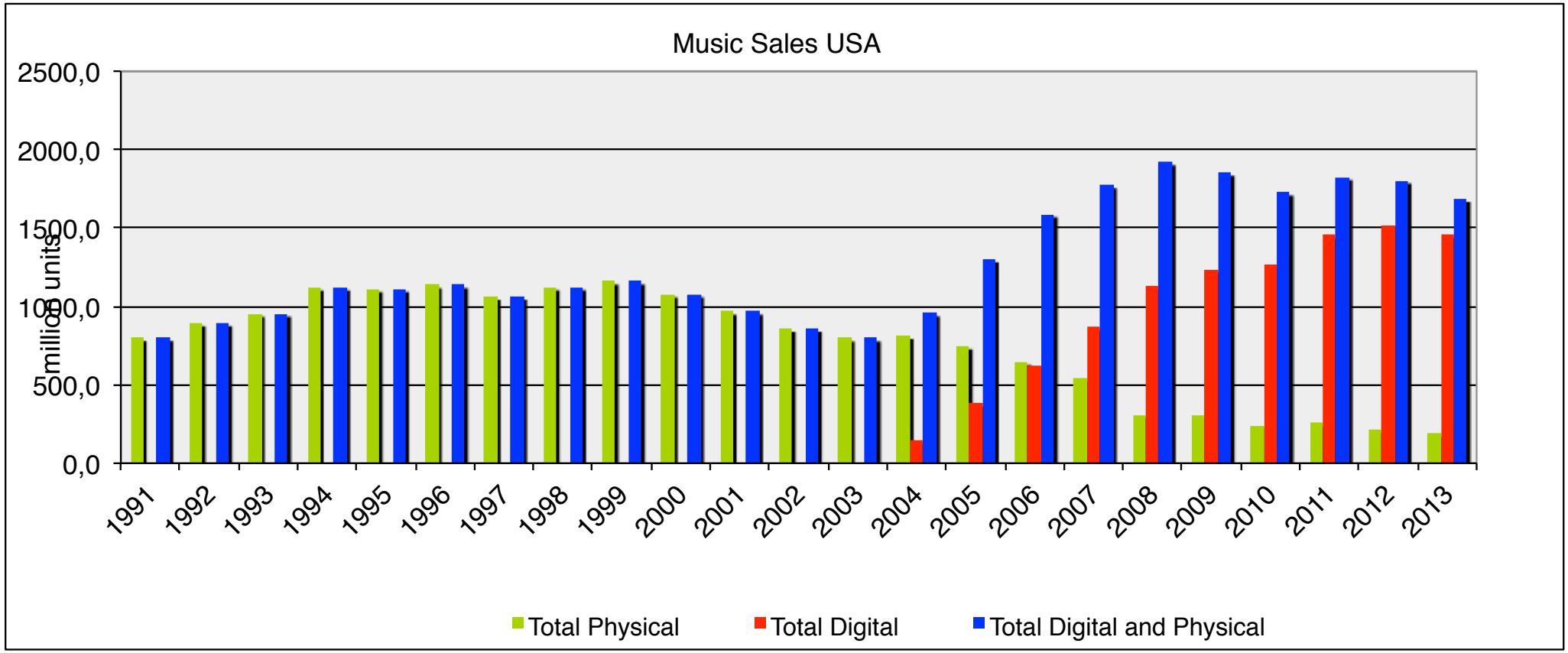
http://www.azoz.com/music/features/0008.html

Each downloaded or copied file is equal to lost sales income –

is it?

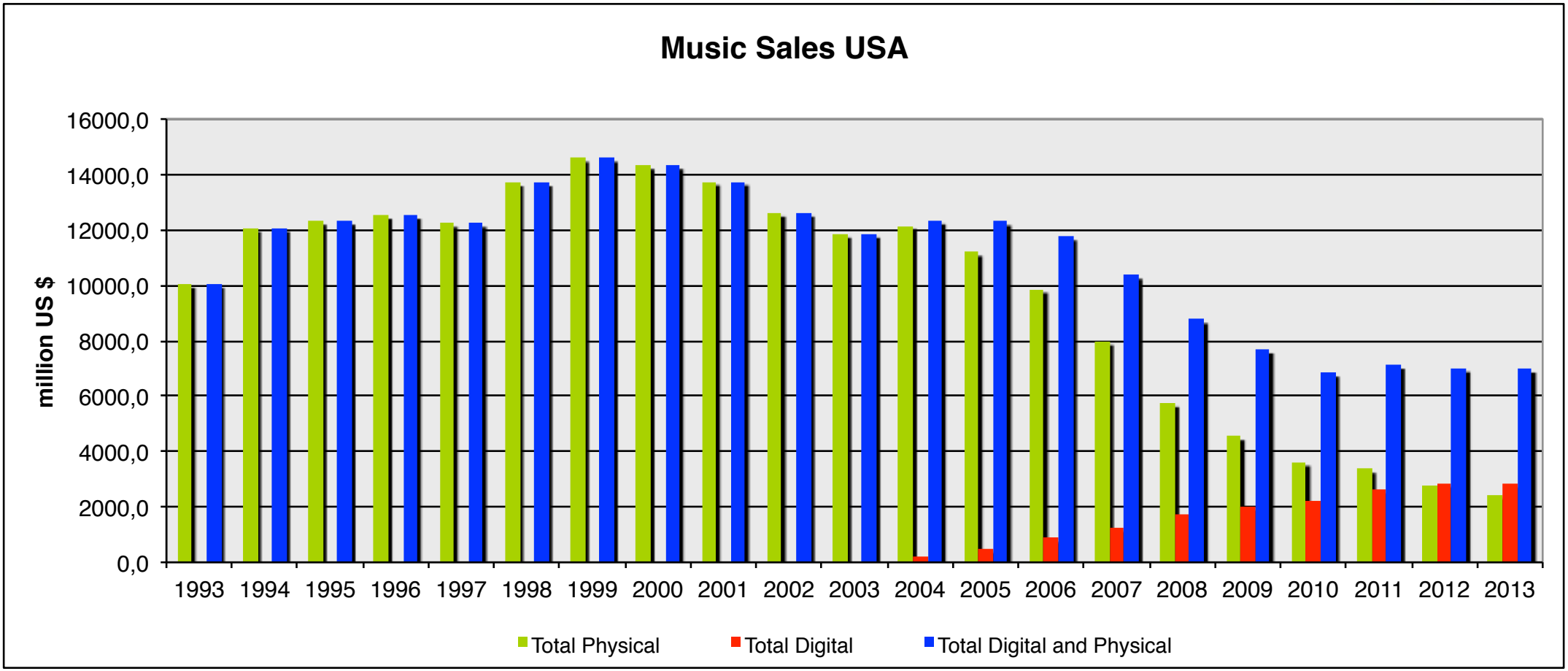
IFPI Germany press release 21.3.2002:
"Mass music copying and music piracy in the Internet threatens music markets"

Music Sales Statistics (1)



Units shipped
Data: RIAA (riaa.com)

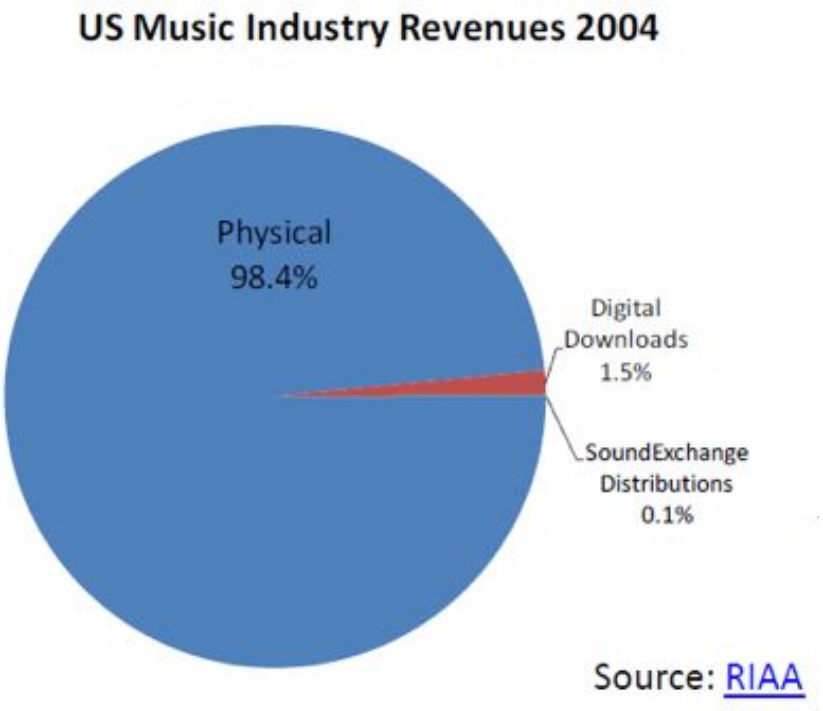
Music Sales Statistics (2)

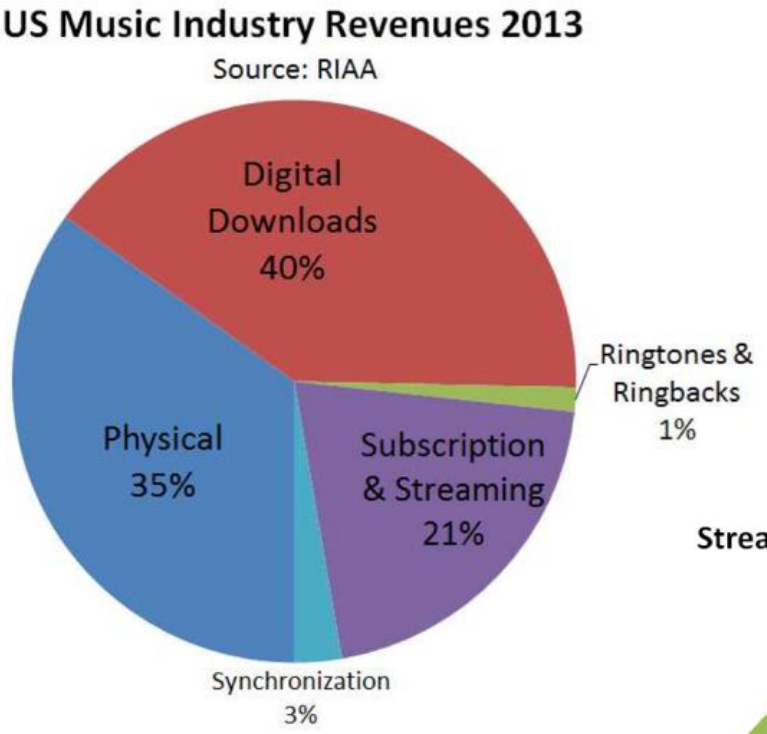


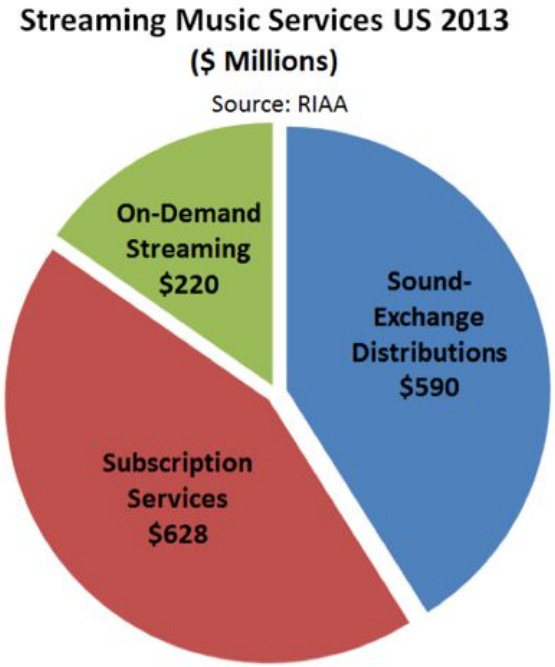
Retail value
Data: RIAA (riaa.com)

Analog physical (vinyl) in 2013:
US$ 213.7 million = 3 % of total revenue

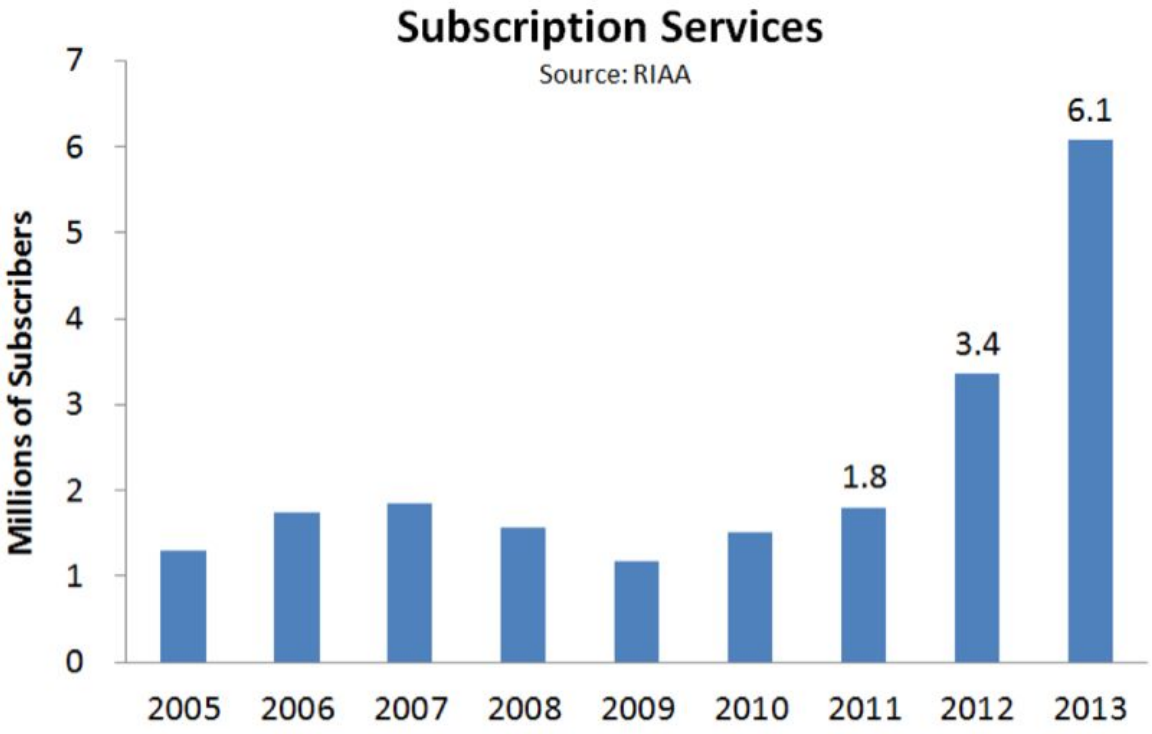
Changes in Revenue Generation

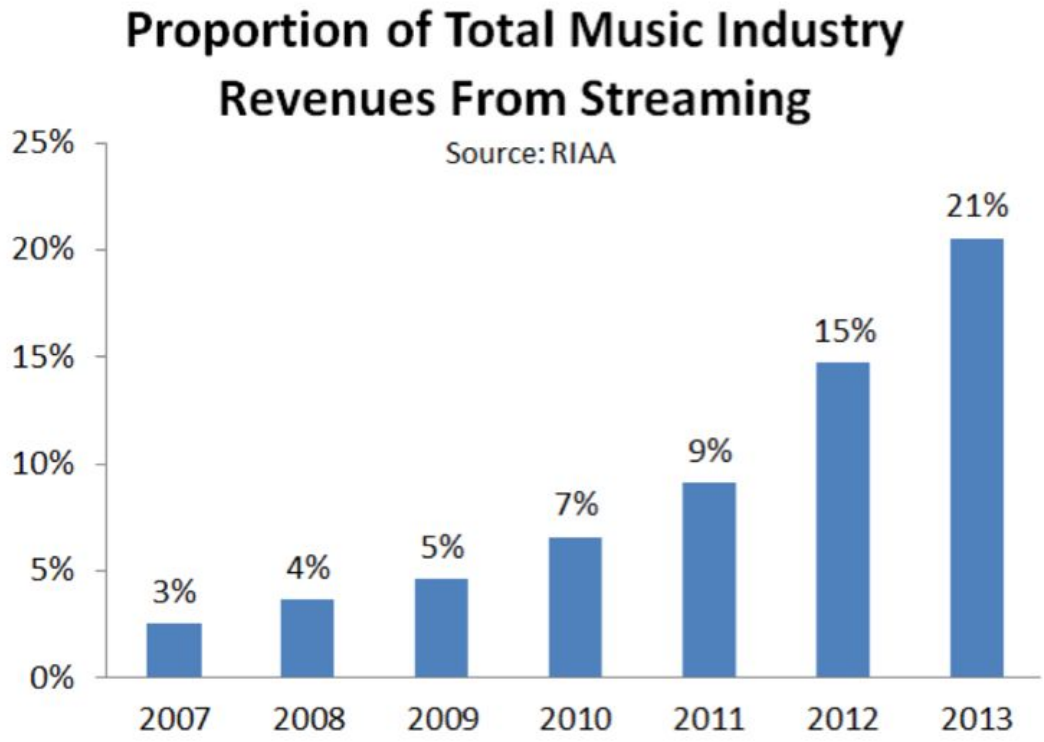


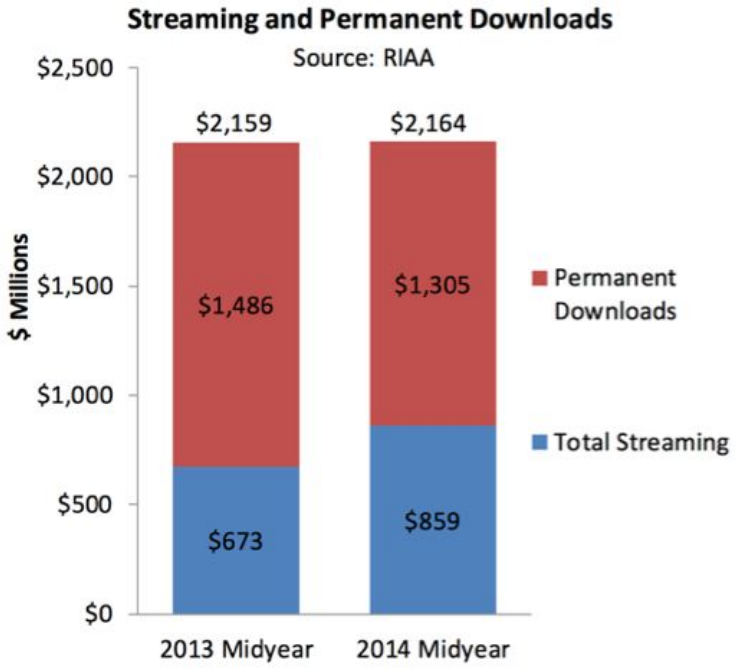




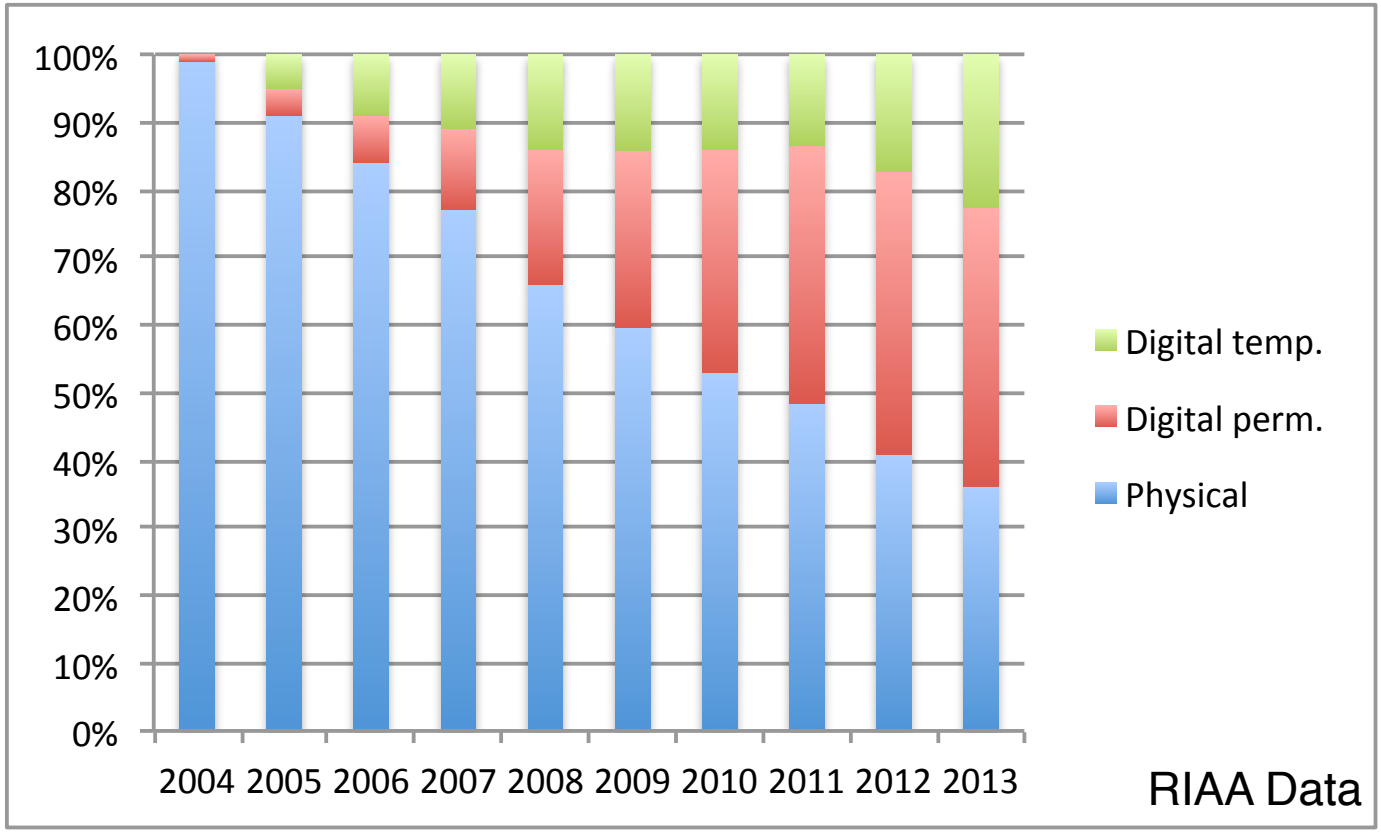
US Music Streaming Market







Trends in Music Sales



- Overall market volume is almost stable
- Physical distribution is being reduced to a small market share
- Permanent downloads are stagnating in market share
- Temporary distribution (streaming) is rapidly increasing
- Discussion: Effects of piracy?
  - Think also:
    Novelty effect, finding music, revenue through concerts & merchandise

6 Digital Rights – Definition and Management

Literature:

Bill Rosenblatt, Bill Trippe, Stephen Mooney: Digital Rights Management – Business and Technology, M&T Books 2002

Wenjun Zeng, Heather Yu, Ching-Yung Lin: Multimedia Security Technologies for Digital Rights Management, Academic Press

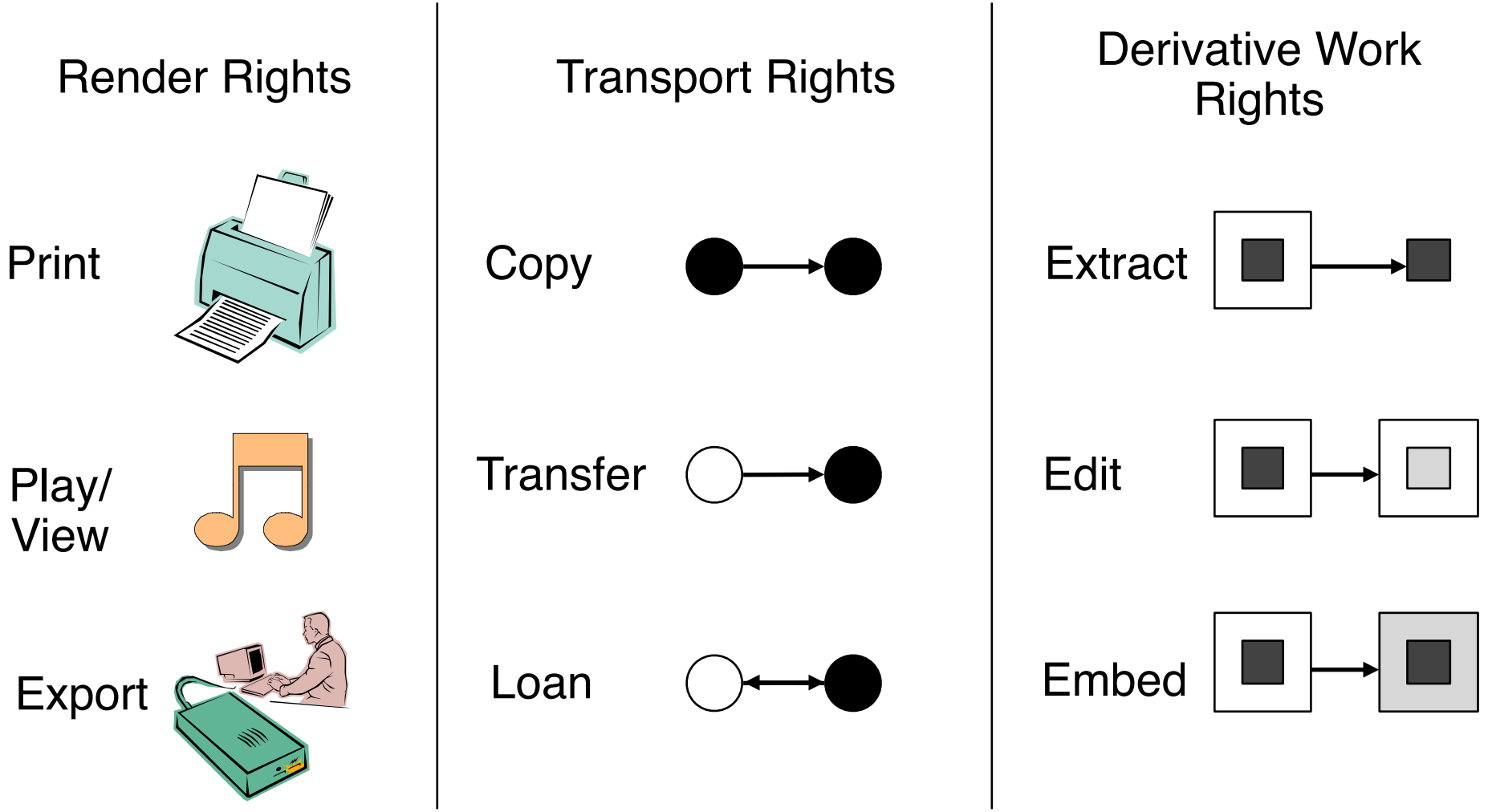
Mark Stefik: Internet Dreams - Archetypes, Myths, and Metaphors, MIT Press 1996

Examples for Content Rights Transactions

- Buying a book, the buyer gets:
  - The right to read one copy of the physical book arbitrarily often
  - The right to sell or give the book to someone else
  - He does *not* get the rights to, e.g.:
    - » To perceive the book in a different technology (eBook, audio book)
    - » To quote from the book in own publications beyond fair use
- Buying a cinema ticket, the buyer gets:
  - The right to see the movie once (or sometimes until the theatre closes)
  - He does *not* get the rights to, e.g.:
    - » Let a friend see the movie
    - » Make a video recording of the movie
- Listening to a song on the radio, the listener gets (without paying)
  - The right to listen to the song
  - The right to record it for personal use

Fundamental Types of Rights

- According to Mark Stefik, Xerox PARC (“Letting Loose the Light”)



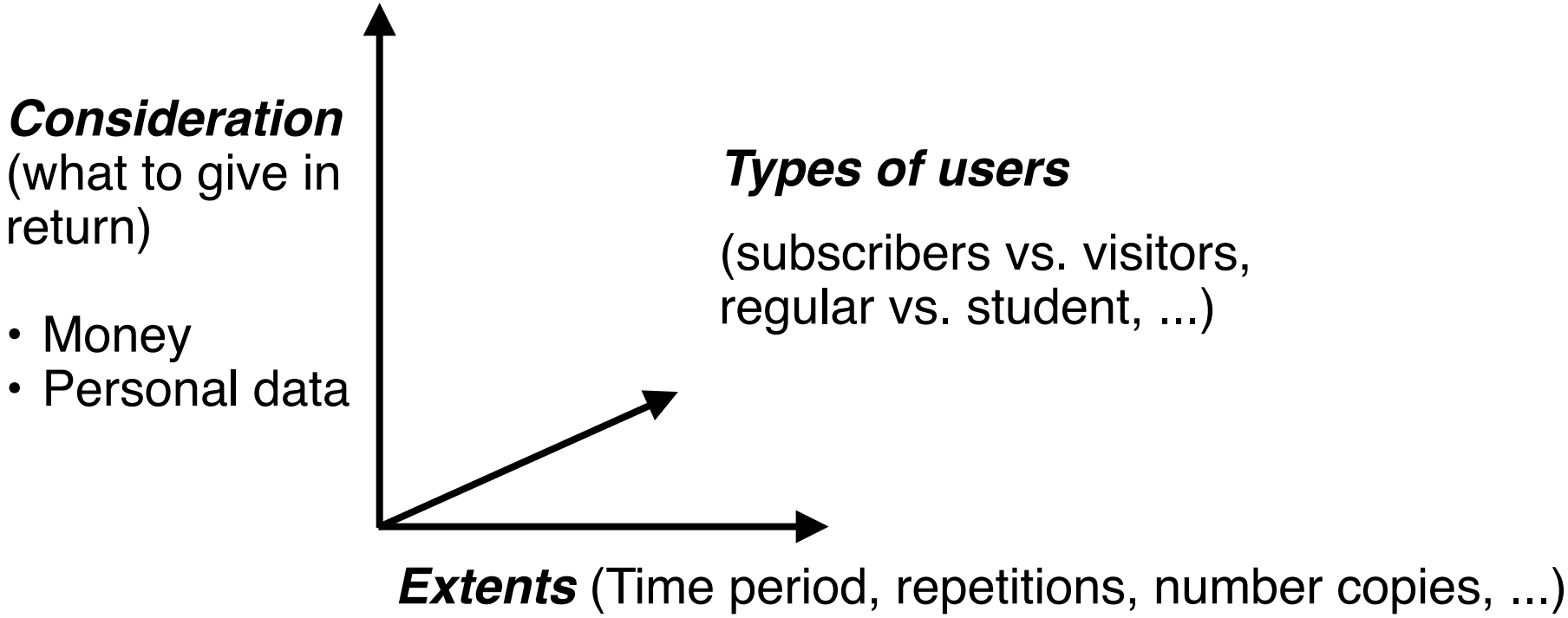
Utility Rights

- Additional types of rights which exist for technological reasons rather than to support publishers' business models

- Backup rights:
  - Right to make a copy as a safety means against technical failure
- Caching rights:
  - Right to make temporary local copies to improve performance
- Data integrity rights:
  - Right to create redundant code information etc. to ensure that the data does not get corrupted

Rights Attributes

- Rights attributes are additional specifications added to each of the fundamental rights
- Rights model = fundamental rights + rights attributes



Examples (Basic Rights Language) (1)

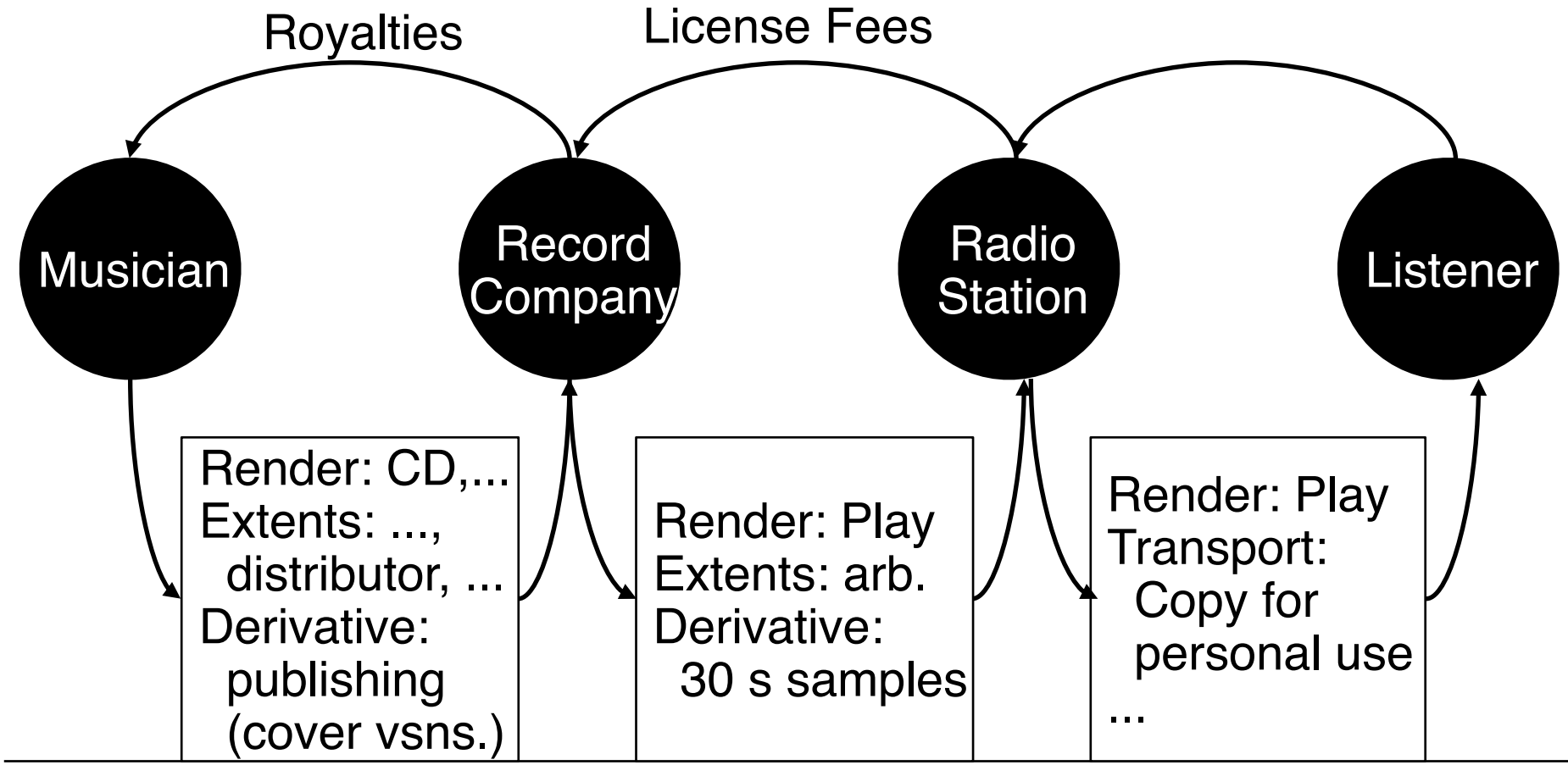
- Buying a book:
  - **Render rights:** Print
    - » Consideration: Price of the book
    - » Extent: Forever, one copy only
    - » Type of user: No distinctions
  - **Transport rights:** Sell, give away, loan
    - » No restrictions
  - **Derivative rights:** None
- Buying a cinema ticket:
  - **Render rights:** Play
    - » Consideration: Price of movie ticket
    - » Extent: Once or rest of the day
    - » Type of user: Adult or child
  - **Transport rights:** None
  - **Derivative rights:** None

Examples (Basic Rights Language) (2)

- Listening to a song on the radio
  - **Render rights:** Play
    - » Consideration: None
    - » Extent: Once for each receiver
    - » Type of user: No distinction
  - **Transport rights:** Copy for personal use
    - » Consideration: Percentage of the cost of the recording media
    - » Extent: Personal use only
    - » Type of user: No distinction
  - **Derivative rights:** None

Chains of Rights Transactions

- Rights transactions always take place in chains
- Each transaction creates a new set of rights
- Example:



Rights Transactions May Change Rights

- Recording a tape from radio is a step in a chain of rights transactions
- After recording, the rights on the record change:
  - Extent of the render right is now “forever”
  - New derivative rights are added, e.g.:
  - **Derivative right:** Extract and embed rights for commercial use
    - » Consideration: None
    - » Extent: Only 30 seconds samples
    - » Type of user: Commercial

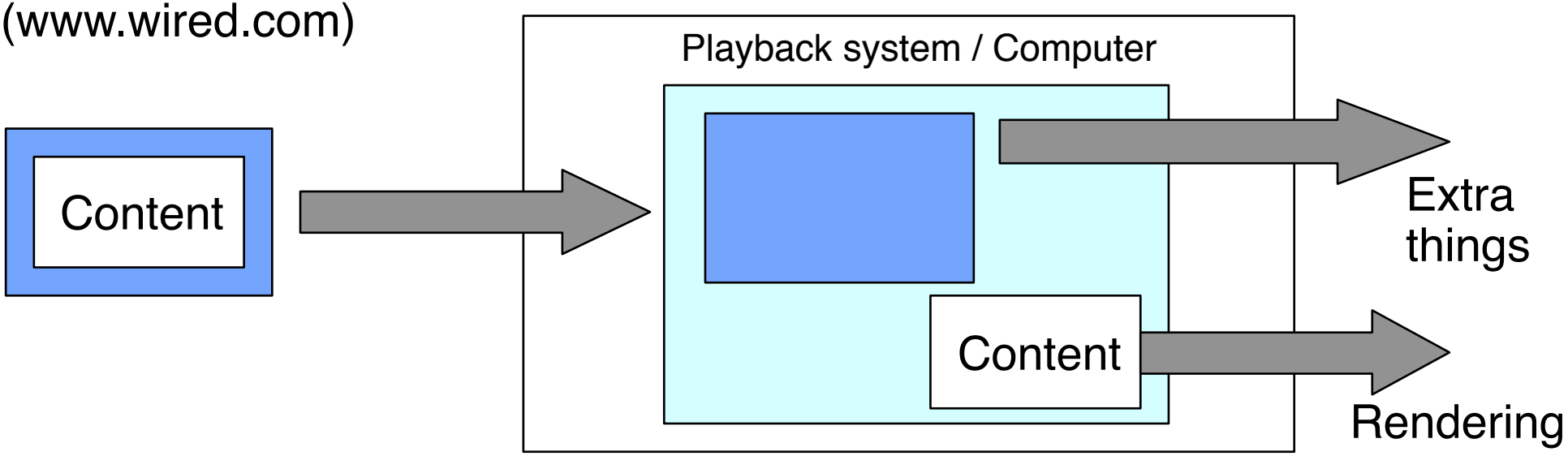
Rights Models and Digital Media

- Example: Music or video download service
  - **Render rights:** View
    - » Consideration: Price of the download
    - » Extent: Forever
    - » Type of user: No distinction
  - **Transport rights:** None
  - **Derivative rights:** None

- Practical questions:
  - How to ensure that the transport rights are obeyed (i.e. the file is not copied to other people)?
    - » Legal measures: How to prove from where the file came?
    - » Technical measures: How to make content viewable only for uniquely identified users?
  - These are technical challenges of DRM technology

Superdistribution

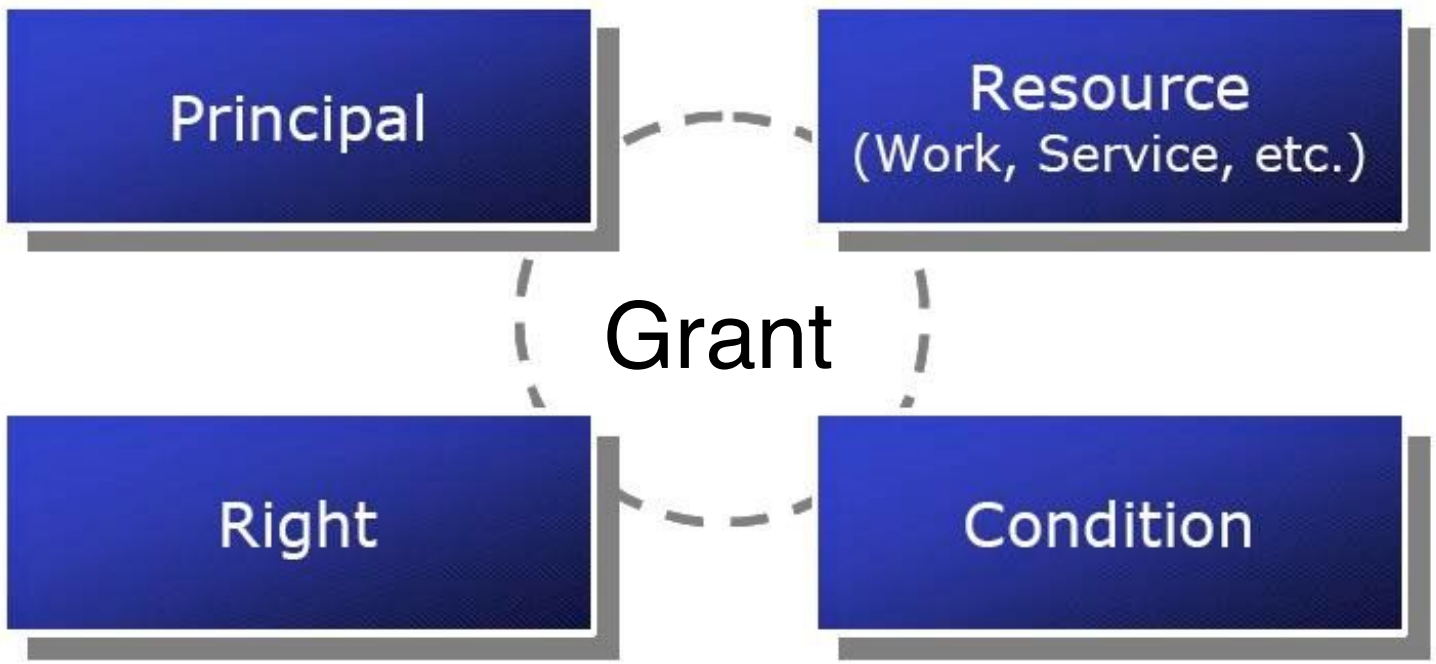
- Basic idea (Ryoichi Mori): *A software object cannot easily determine whether it has been copied or not, but it can easily be built to do some extra things when run.*
  - "Extra things" may be: metering, billing, requiring a license, …
- Superdistribution needs to be enabled at :
  - Content: "Wrapped" with superdistribution component
  - Computer: Executes superdistribution routines when accessing content
- Brad Cox: Superdistribution, *Wired Magazine*, Issue 2.09, Sep 1994 (www.wired.com)



Implementing Rights Models

- Mark Stefik, Xerox Labs
  - "Letting Loose the Light: Igniting Commerce in Electronic Publication", in: Internet Dreams, MIT Press 1996
  - *Digital Property Rights Definition Language (DPRL)* (Lisp-like syntax)
- ContentGuard (Xerox spin-off company, partially owned by Microsoft)
  - DPRL idea in XML syntax: *XrML (Extensible Rights Management Language)*
- Impact of XrML:
  - Microsoft implements XrML in its Unified DRM solution
  - ISO standard ***MPEG-21 "Rights expression language" (REL)***
  - Open eBook Forum adopted MPEG-21 REL
- Distinguish between two key questions:
  - How to *specify the rights*
  - How to *enforce* that the *usage* obeys the rights

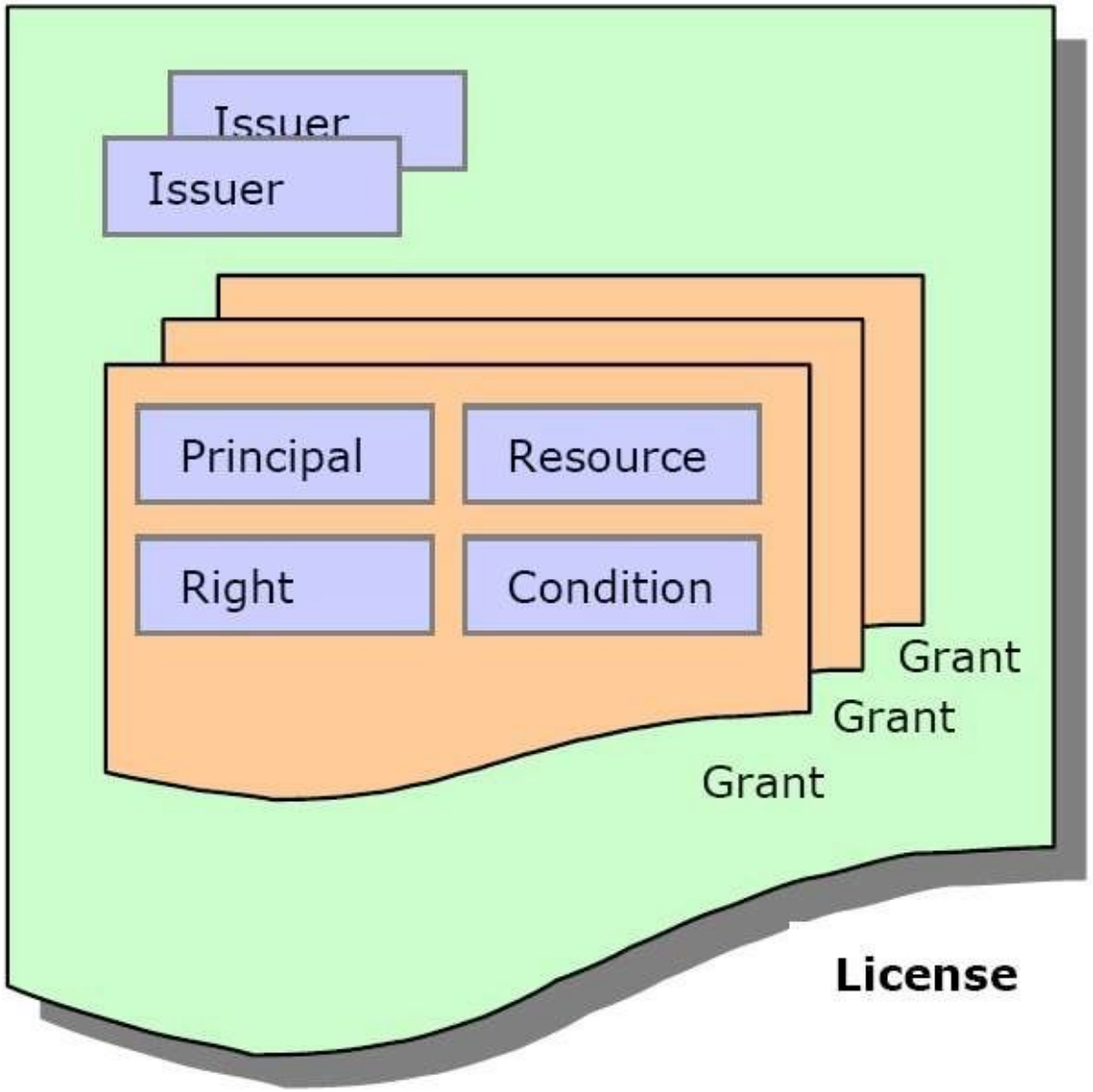
XrML Terminology: Grant



- Principal: Identification of a party to which rights are granted
- Right: A “verb” that the principal is granted to execute on a resource
- Resource: Object to which the grant refers (e.g. audio file or service)
- Condition: Specifies the terms under which the grant is valid

From XRML 2.0 Technical Overview

XrML Terminology: License



- *License* defines a set of grants
  - plus identification of issuer(s)
  - plus additional information like description, validity date, ...

From XRML 2.0 Technical Overview

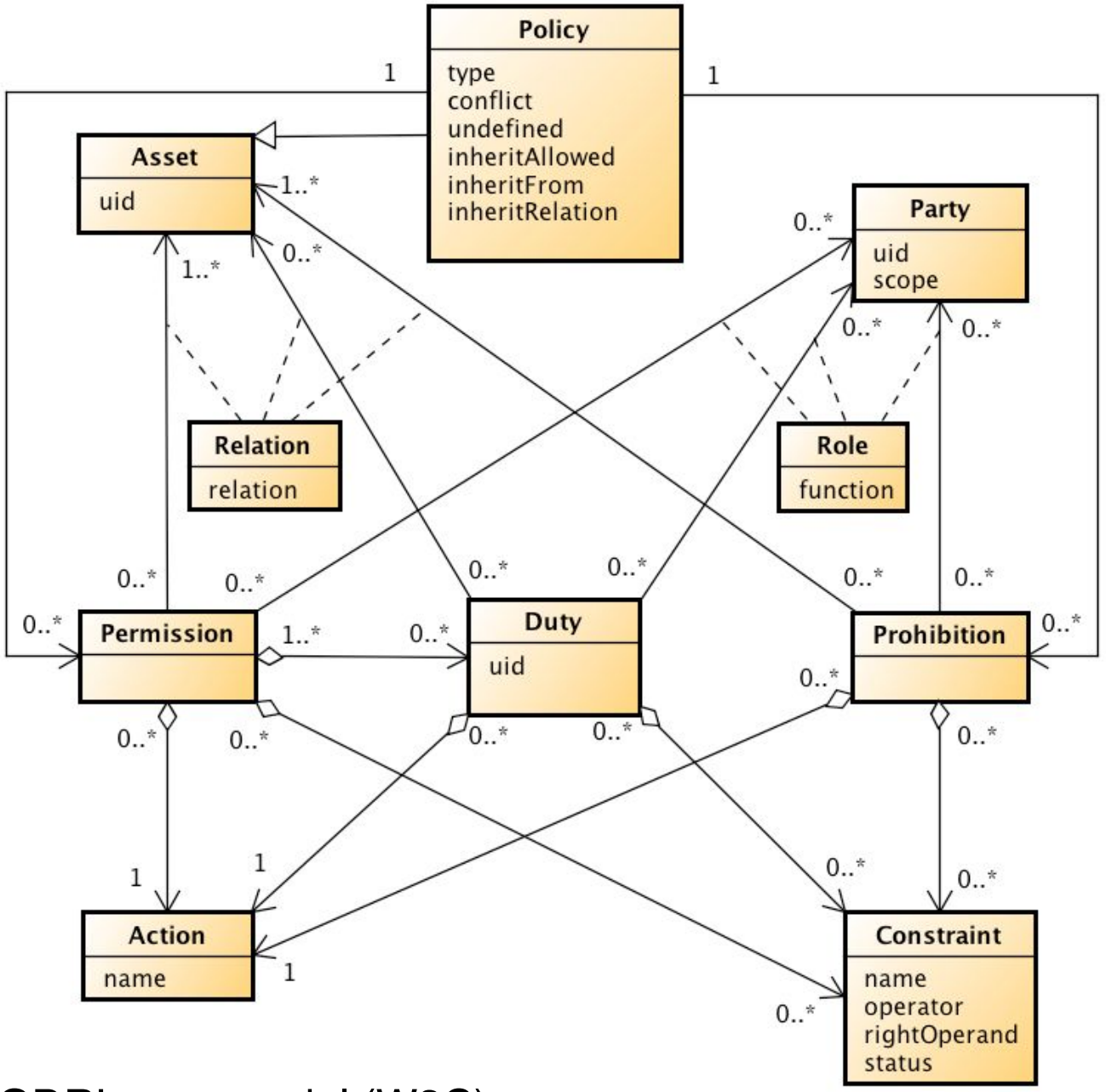
XrML Content Extension

- Specific XrML language elements for digital multimedia content
- Specific rights:
  - File Management Rights (accessFolderInfo, backup, delete, ...)
  - Render Rights (export, play, print)
  - Transport Rights (copy, loan, transfer)
  - Derivative Work Rights (edit, embed, extract)
  - Configuration Rights (install, uninstall)
- Specific resources:
  - DigitalWork
  - DigitalWorkMetadata
- Specific conditions:
  - Helper (software to exercise a right)
  - Renderer (device to render a work)
  - Watermark (information to be embedded)

From XRML 2.0 Technical Overview

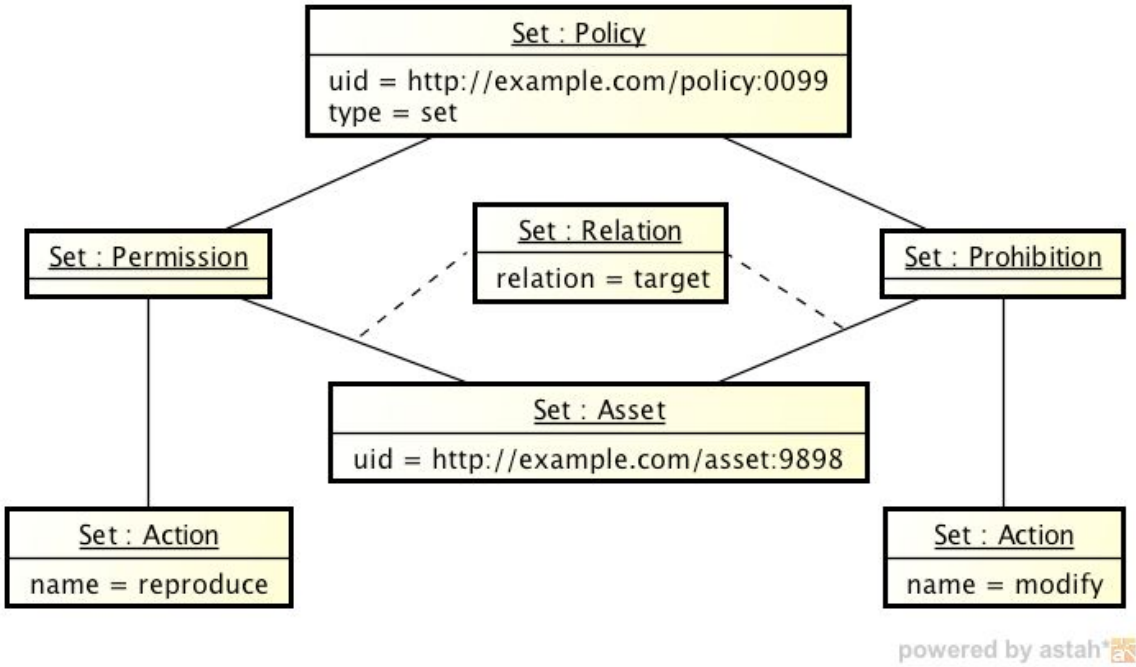
ODRL

- Open Digital Rights Language ODRL
- Originally by the Open Mobile Alliance (OMA), formerly WAP Forum)
- XML language, standardized through W3C
  - Final specification of version 2.0 in April 2012
  - Becoming popular in e-book and news distribution standards



ODRL core model (W3C)

ODRL Example




```
<o:policy xmlns:o="http://w3.org/ns/odrl/2/" type="http://w3.org/ns/odrl/vocab#set"
uid="http://example.com/policy:0099">
    <o:permission>
        <o:asset uid="http://example.com/asset:9898"
              relation="http://w3.org/ns/odrl/vocab#target"/>
        <o:action name="http://w3.org/ns/odrl/vocab#publish"/>
    </o:permission>
    <o:prohibition>
        <o:asset uid="http://example.com/asset:9898"
              relation="http://w3.org/ns/odrl/vocab#target"/>
        <o:action name="http://w3.org/ns/odrl/vocab#modify"/>
    </o:prohibition>
</o:policy>
```

Source: W3C

Creative Commons REL

```
<div xmlns:cc="http://creativecommons.org/ns#">
  <a rel="license" href="http://creativecommons.org/licenses/by/3.0/">
    <img src="http://i.creativecommons.org/l/by/3.0/88x31.png" />
  </a>
  <br />
  This page, by
  <a property="cc:attributionName"
     rel="cc:attributionURL"
     href="http://lessig.org/">Lawrence Lessig</a>,
  is licensed under a
  <a rel="license" href="http://creativecommons.org/licenses/by/3.0/">
    Creative Commons Attribution License</a>.
</div>
```

See: http://labs.creativecommons.org/2011/ccrel-guide/

- Expresses CC licenses in formal, machine-readable form
- Using XML, embeddable into HTML
- Based on Semantic Web technologies (RDFa)

6 Digital Rights – Definition and Management

Literature:

Bill Rosenblatt, Bill Trippe, Stephen Mooney: Digital Rights Management – Business and Technology, M&T Books 2002

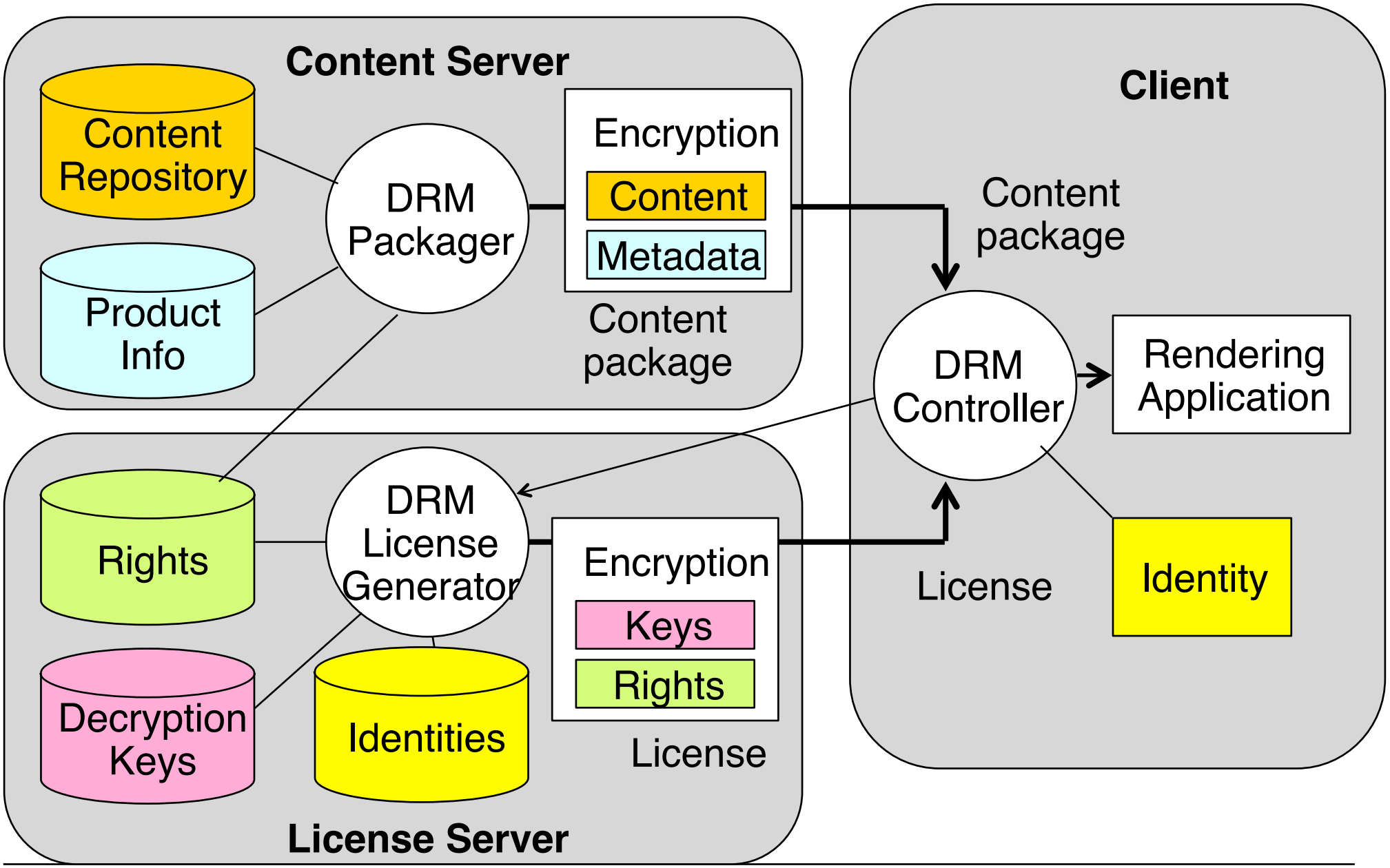
Seth Schoen: Trusted Computing - Promise and Risk, http://www.eff.org/Infrastructure/trusted_computing

Eberhard Becker et al.: Digital Rights Management – Technological, legal and political aspects, Springer 2003 (LNCS 2770)

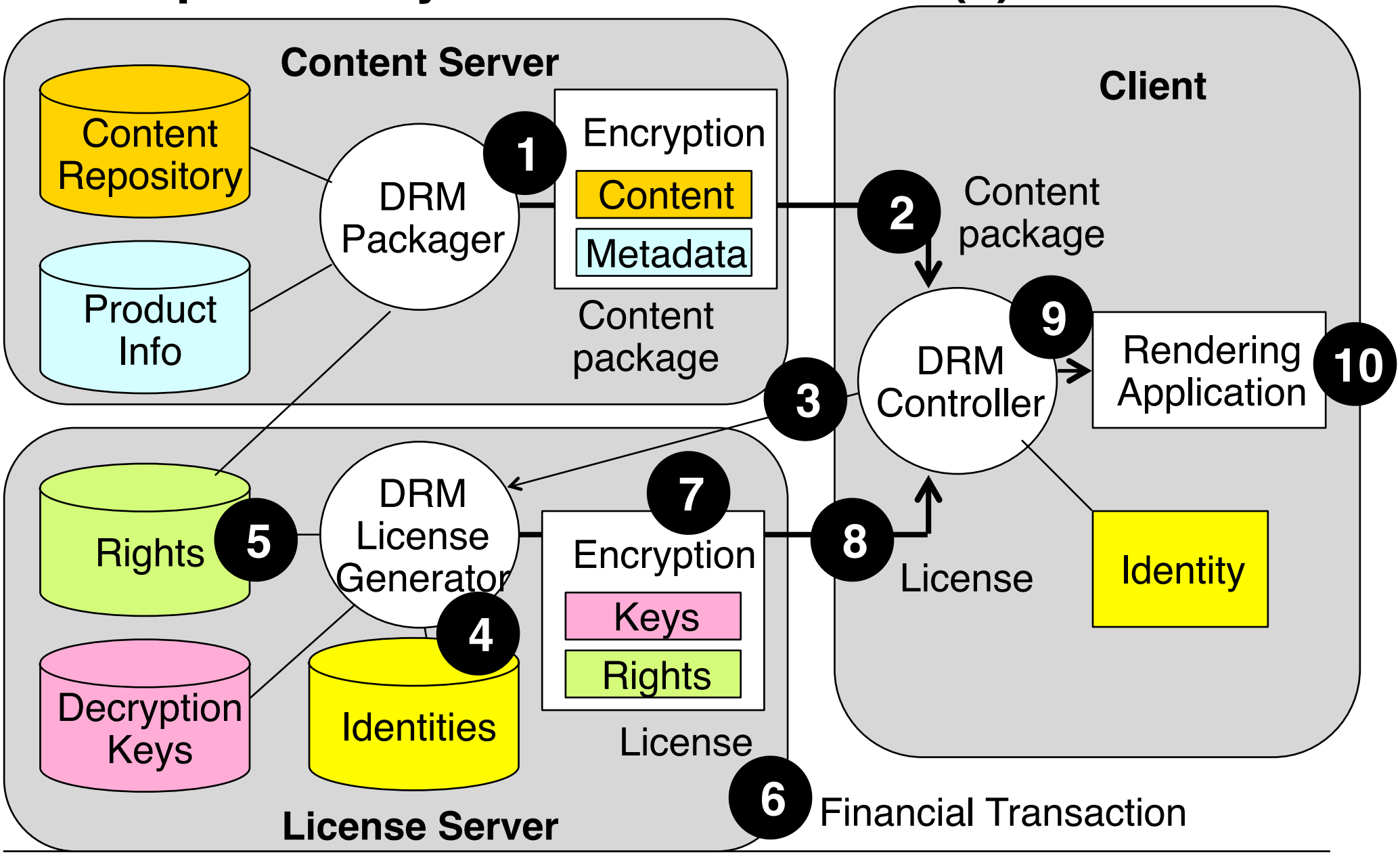
Encryption-Based DRM

- Content is transmitted to users only in *encrypted* form
  - Not readable/playable without decoding using appropriate *keys*
- A *license* contains keys, coupled with *rights*
  - Rights specified according to a rights model
  - Keys have to be inseparable from rights
  - Licenses can and should be separate entities from content files
    - » Different licenses for same content
    - » One license for many pieces of content
- *User identities*
  - Ensure that rights are granted to a specific person or organization
  - Corresponds to the “principals” of XrML
- *Device identities*
  - Ensure that restrictions on device usage are checkable
  - E.g. using some content only on a limited number of devices

A DRM Reference Architecture



10 Steps To Play Protected Content (1)



10 Steps To Play Protected Content (2)

(1) User obtains a content package, e.g. by download

(2) User makes request to exercise rights, e.g. to play or store the content

Rendering software activates the DRM controller

(3) DRM controller identifies user and content, contacts license server

May require user interaction, e.g. filling a registration form

(4) License server authenticates user against identities database

(5) License server looks up rights specification for the requested content

(6) If necessary, a financial transaction is started

Financial transaction may happen also at another point in the process

(7) License generator combines rights information, client identity and decryption keys and seals them (packaged by encryption)

(8) License is sent to the client

(9) DRM controller decrypts the content and hands it over to the rendering application

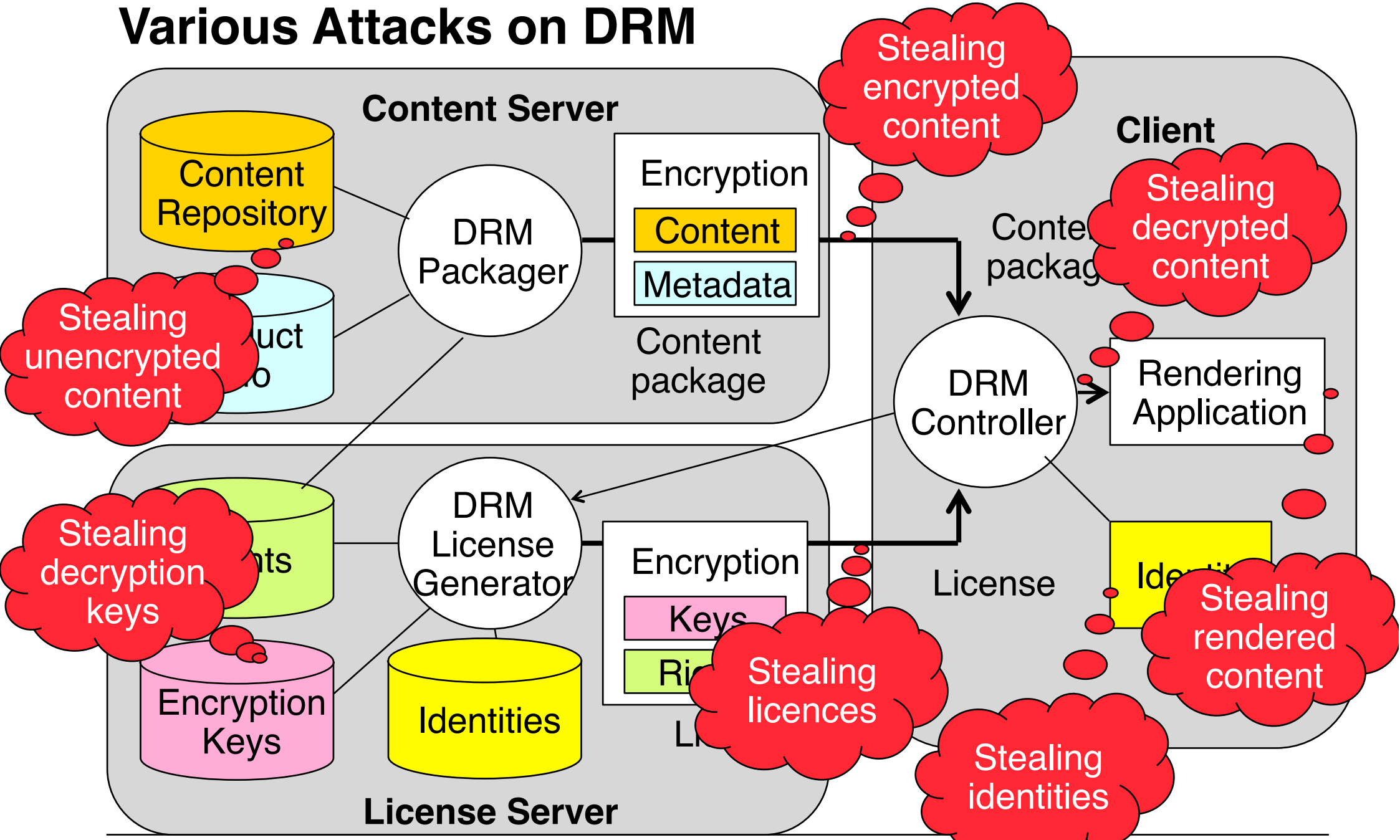
(10) Content is rendered for the user

Identification

- User identification
  - Supplied by user: User name, password
    - » Can be passed on from user to user
  - Inherent: Biometric data
  - Supplied by trusted third party: Digital certificate

- Device identification
  - Serial number readable by software
    - » Processor or other hardware components
  - IP address
    - » Unsuitable, due to techniques like NAT (network address translation)
  - Combination of various identifying information
    - » E.g. various serial numbers, MAC addresses, ...

Various Attacks on DRM



Integration DRM Controller – Rendering

- Coupling between DRM Controller and rendering application: has to be very tight
  - Intermediate storage of decoded data in file or socket would be harmful
- DRM Controllers in rendering software of high market domination
  - E.g. Adobe Acrobat, various eBook readers
  - E.g. Microsoft Windows Media Player, Apple iTunes & QuickTime
- DRM Controllers built into specialized devices
  - E.g. Apple iPod
- General problem:
  - Decoded digital signal has to be stored and transmitted somewhere (in the computer software)
  - Possibility to capture decoded signal on hardware or operating system level
    - » Except with “trusted systems”…

Trusted Computing and DRM

- Microsoft initiative: “Palladium” architecture (re-named “Next Generation Secure Computing Base (NGSCB)”)
- “Trusted Computing Group (TCG)” (https://www.trustedcomputinggroup.org/)
- Authentication and validation of software and documents built into operating system and based on “tamper-proof” hardware
  - Promises:
    - » (Almost) unbreakable realization of DRM
    - » Complete control over software licensing
    - » Secure storage for sensitive information like electronic money or valuable keys

TPM = Trusted Platform Module

- Hardware (TPM) (last version of spec 2011)
  - present in business grade computers (“secure boot”)
  - not legally allowed in some countries
  - Microsoft uses TPM in “BitLocker” encryption (Windows Vista, 7+8)

The General Questions

- Is it possible to ensure that only licensed users play back media files, using technical measures only?
- What is the trade-off between
  - control of the user over his/her owned device and media collection, and
  - copyright enforcement?
- Is the effort spent on copy-protection worthwhile?
  - Criteria for selecting a platform to consume digital media?
  - Economic considerations?

> So if the music companies are selling over 90 percent of their music DRM-free, what benefits do they get from selling the remaining small percentage of their music encumbered with a DRM system? There appear to be none. If anything, the technical expertise and overhead required to create, operate and update a DRM system has limited the number of participants selling DRM protected music. If such requirements were removed, the music industry might experience an influx of new companies willing to invest in innovative new stores and players. This can only be seen as a positive by the music companies.

Steve Jobs,
Thoughts on Music,
2008