Multimedia im Netz

Wintersemester 2010/2011

Part II

Content-Oriented Base Technologies for Networked Multimedia

Outline

1.	Introduction and Motivation	
2.	Media on the Web	Part I: Web Technologies for Interactive MM
3.	Interactive Web Applications	
4.	Communities, the Web, and Multimedia	
5.	Digital Rights Management	Part II: Content-Oriented Base Technologies
6.	Cryptographic Techniques	
7.	Multimedia Content Description	
8.	Streaming Architectures	Part III: Multimedia Distribution Services
9.	Web Radio, Web TV and IPTV	
10.	Electronic Books and Magazines	
11.	Multimedia Content Production and Management	
12.	Multimedia Conferencing	Part IV: Conversational Multimedia Services
13.	Signaling Protocols for Multimedia Communication	
14.	Visions and Outlook	

5 Digital Rights Management

5.1 Media Rights
5.2 Rights Models
5.3 Principles of Encryption-Based DRM Systems
5.4 Watermarking
5.5 DRM Standards and Selected Commercial Solutions

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 2006

Urheberrecht (Intellectual Property Right IPR)

- Geschichte:
  - “Geistiges Eigentum” in Antike und Mttelalter unbekannt
  - Autorenprivilegien (seit 1486) (Buchdruck 1440)
  - Theorie vom geistigen Eigentum seit ca. 1700
- Aufgaben des Urheberrechts:
  - Sicherung von Nutzungs-, Veröffentlichungs- und Verwertungsrechten für den Urheber eines Werkes
  - Rechte bestehen direkt und registrierungsunabhängig
    - » Anders als z.B. bei Patenten und Markennamen
- Territorialprinzip
  - Regionale Gesetze
  - Wenige internationale Abkommen
    - » WIPO = World Intellectual Property Organisation (www.wipo.int)
    - » 150 Teilnehmerstaaten

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

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
  - This is a 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)

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 Deutschland

- Urheberrechtsgesetz (UrhG) 1965
- Novelliert 2003 in Anpassung an die EU-Info-Richtlinie und die WIPO-Abkommen (“Erster Korb”)
  - Künstlerische und ästhetische Interessen des Urhebers an seinem Werk (nur natürliche Personen, nicht wie in den USA auch juristische)
  - Anreiz für Urheber, weiter Werke herzustellen
  - Sicherung einer angemessenen Vergütung
  - Eigentümerstellung des Urhebers fast so stark wie bei einer materiellen Sache
- Zweierlei Rechte:
  - Urheber-Persönlichkeitsschutz
    - » Nicht veräußerlich (kann nicht verkauft, verschenkt, vererbt werden)
  - Verwertungsrechte
    - » Urheber bestimmt, ob Werk vervielfältigt werden darf
    - » Privatkopie (Vervielfältigung zum eigenen Gebrauch) im Prinzip immer erlaubt (§53) – aber eingeschränkt durch §95a!

Aktuelle Entwicklung im deutschen Urheberrecht

Weitere Reform des UrhG („Zweiter Korb“), Gesetz seit 2008

- Privatkopie und Tausch:
  - Privatkopie kopiergeschützter Materialien verboten (§95a)
  - Tausch von urheberrechtlich geschützten Inhalten über Netzwerke verboten
  - Pauschalvergütung für Privatkopien (Abgaben auf Geräte, mit denen Kopien angefertigt werden können)
  - Vergütungshöhe unter den Beteiligten auszuhandeln, bei technischem Kopierschutz entfällt der Anspruch auf Vergütung
  - Keine Bagatellklausel (Kabinettsbeschluss 22.3.2006):
    Auch Privatpersonen prinzipiell mit bis zu drei Jahren Haft bedroht
- Urheberrecht in Wissenschaft und Forschung:
  - Relativ großzügige Regelung in §52a gilt nur befristet bis Ende 2012 (§137k)
  - §52b: Digitalisierte Bibliotheksbestände nur an Leseplätzen der Bibliothek nutzbar
    (Ausnahme: Explizit weitergehende Rechte erworben)

http://www.gesetze-im-internet.de/urhg

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
  - Example: Buying a newspaper, buying the right to re-publish content from the newspaper, buying the publishing house
- *Agent:* A legal entity authorized by a rightsholder to enter into a rights transaction on behalf of the rightsholder
- *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)

- The solution found for photocopying: *Copyright Clearance Center*
  - Obtains the rights from publishers to make photocopies (relating to over 1.75 million works)
    - » US: Copyright Clearance Center (CCC), www.copyright.com
    - » Germany: VG WORT (Verwertungsgemeinschaft Wort, www.vgwort.de)
      2008: Income 117 Mio EUR, distributed to over 140.000 authors
      2009: Income 434 Mio EUR, distributed to over 148.000 receivers
    - » International Federation of Reproduction Rights Organizations (IFRRO)
    - » Represents German position in the "Google Books settlement" law case
  - Bundles these rights into an offer to users like copy centers
  - Publicly available photocopy machines can obtain a license from CCC
    - » Similar system in Germany
  - Corporate organizations are charged according to survey data for a given industry branch
  - Recent development: Individual “Pay-per-use” via Internet
- Rather successful, low overhead
- Not the only possibility for rights transactions of this kind
  - Separate agreements with publishers always possible

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), since 2000 SoundExchange (www.soundexchange.com) for digital performance
  - Germany: “Gesellschaft für musikalische Aufführungs- und mechanische Vervielfätigungsrechte” (GEMA, www.gema.de)
- Music is played commercially at a high number of occasions:
  - Radio broadcasting, concerts, restaurants, shops, airlines, soundtracks for movie broadcasts, sound on websites, hold music for telephones, ...
  - This use is not covered by the license obtained with e.g. a CD
  - Additional fees are collected

Traditional Rights Management Solutions (3)

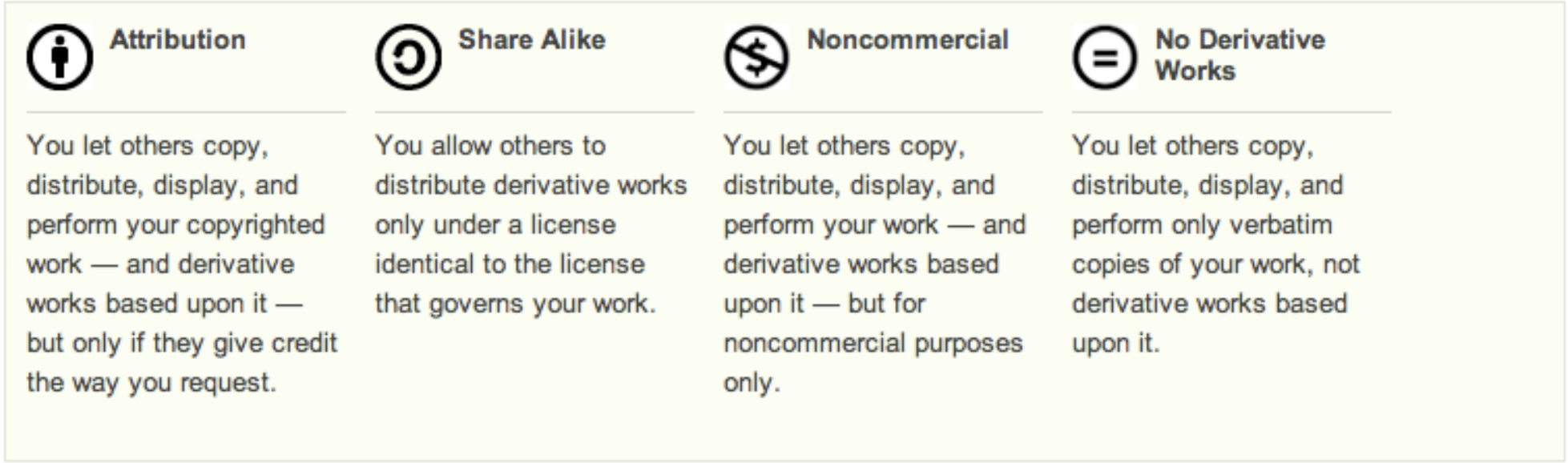
- In the schemes discussed above, the rightsholder is free to admit a certain use or not, depending on a rights transaction.
- *Compulsory licensing:*
  - Government-regulated pricing
  - As soon as user pays an established fee (possibly to a governmental organization), he has certain rights of use
  - Frequently used for patents the broad use of which is needed for the society welfare
    - » Compulsary licensing of “clean air” technologies
    - » Compulsary licensing of unique pharamaceutical products
    - » Sometimes also applied to media (e.g. for National Public Radio in US)
  - Pricing scheme is likely to be “flat”, e.g. monthly fee independent of actual degree of usage and used works

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:



creativecommons.org

Creative Commons Licences

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."

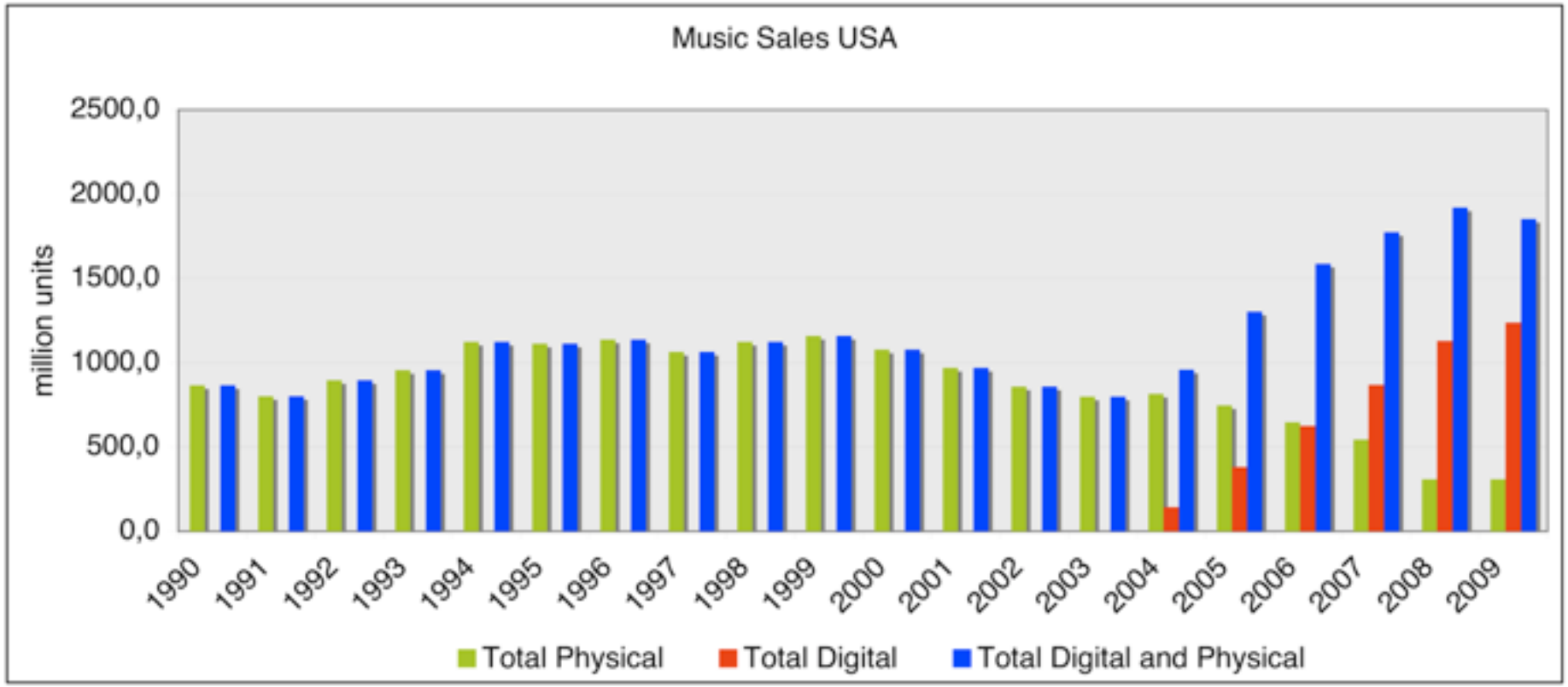
http://www.azoz.com/music/features/0008.html

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

is it?

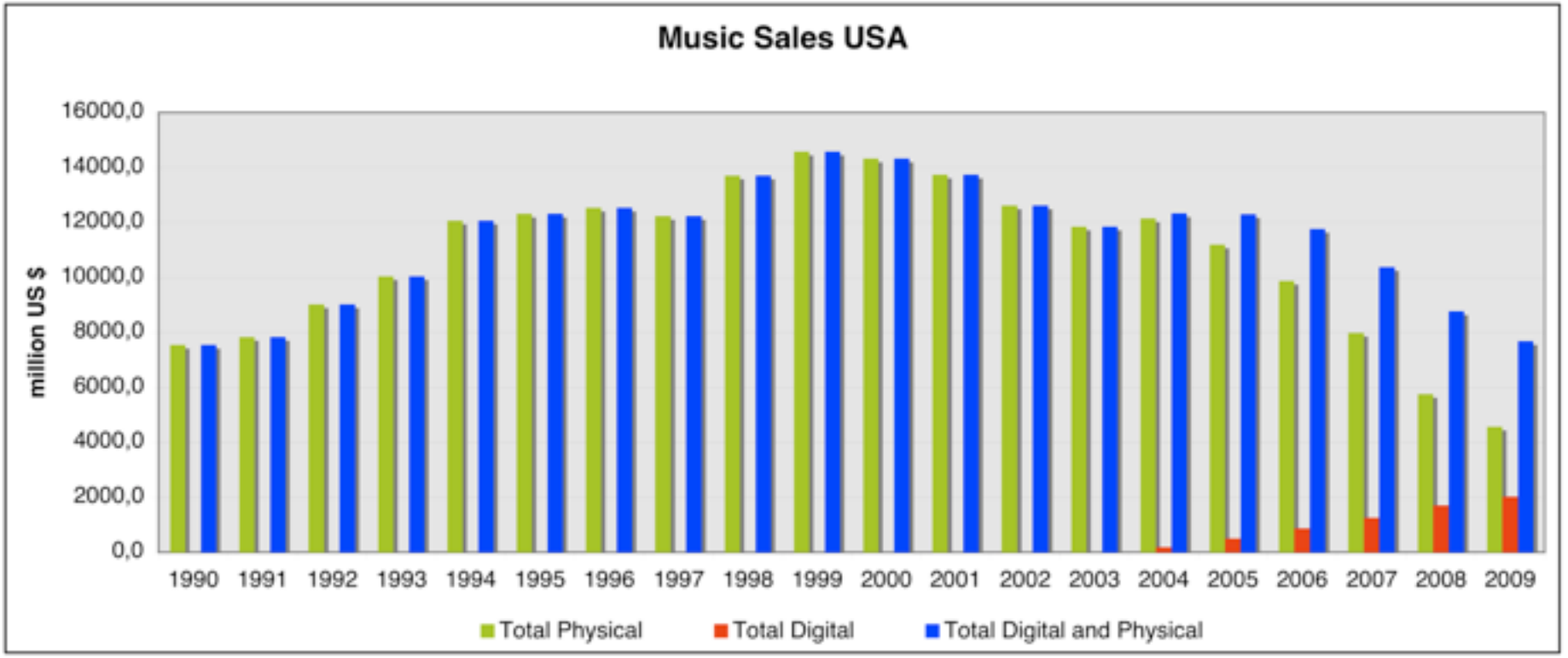
IFPI Germany press release 21.3.2002:
"Mass music copying and music piracy in the Internet threatens music markets"

Music Sales Statistics (1)



Units shipped
Data: RIAA (riaa.com)

Music Sales Statistics (2)



Retail value

Data: RIAA (riaa.com)

Background for Digital Rights Management?

% of Shipments		
Physical	66%	59%
Digital	34%	41%

RIAA Year-End Statistics 2009

- Trends:
  - Physical distribution (CDs) is decreasing rapidly
  - Virtual distribution will soon be the mainstream
  - "Digital performance royalties" (SoundExchange) are increasing rapidly (50% increase from 2008 to 2009, $ 150 mio)
  - Overall music market is shrinking
- Independent positions:
  - The process of finding new music is closely coupled with sharing and copying (it is a social activity)
  - Sharing often leads to later purchases
    - » Not only physical copies (CD), but concert tickets, merchandise etc.
    - » See e.g. Singh et al.: Downloading vs. Purchase, DRMTICS 2005 Conference

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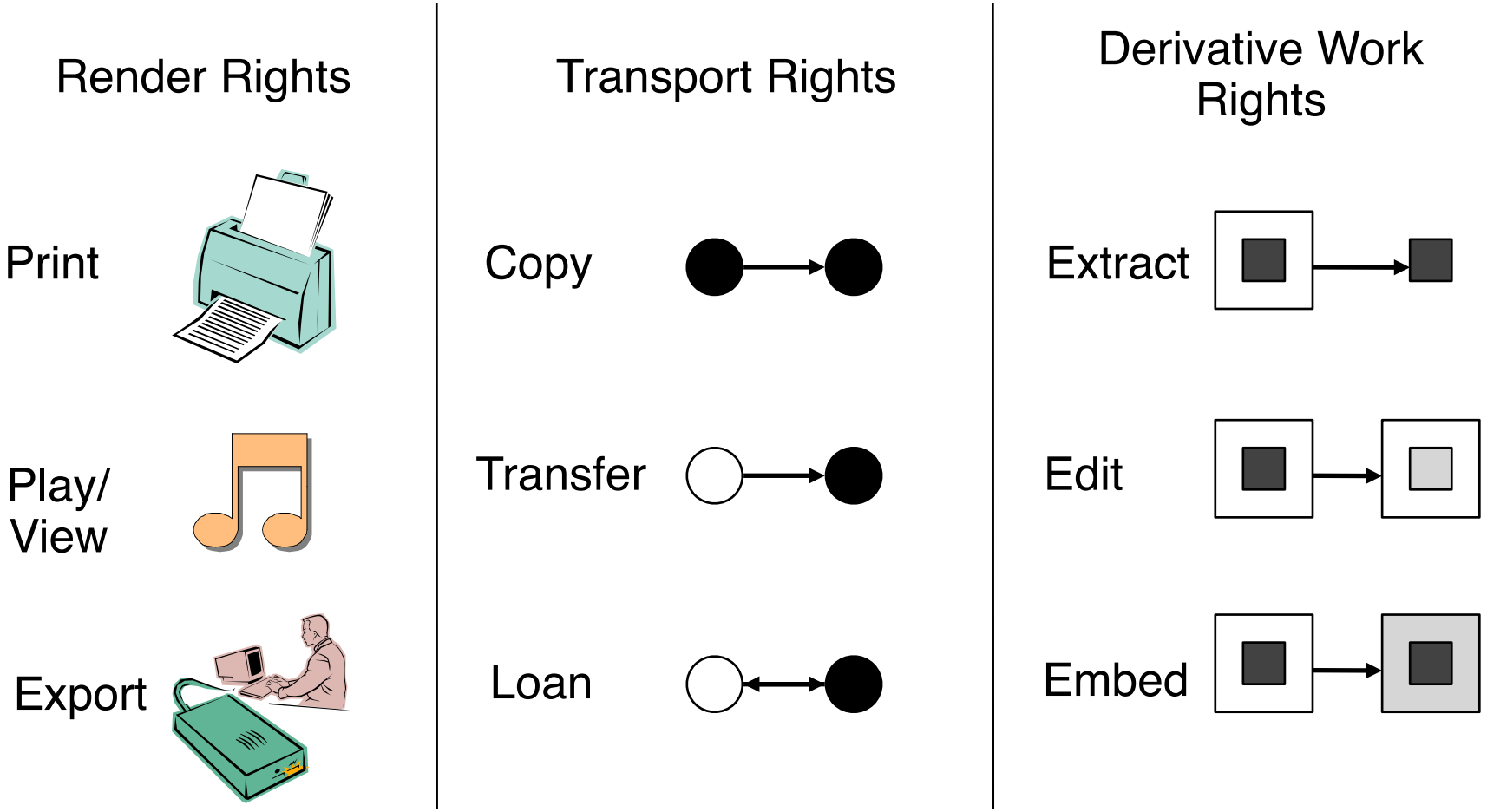
Mark Stefik: Internet Dreams - Archetypes, Myths, and Metaphors, MIT Press 1996

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”)



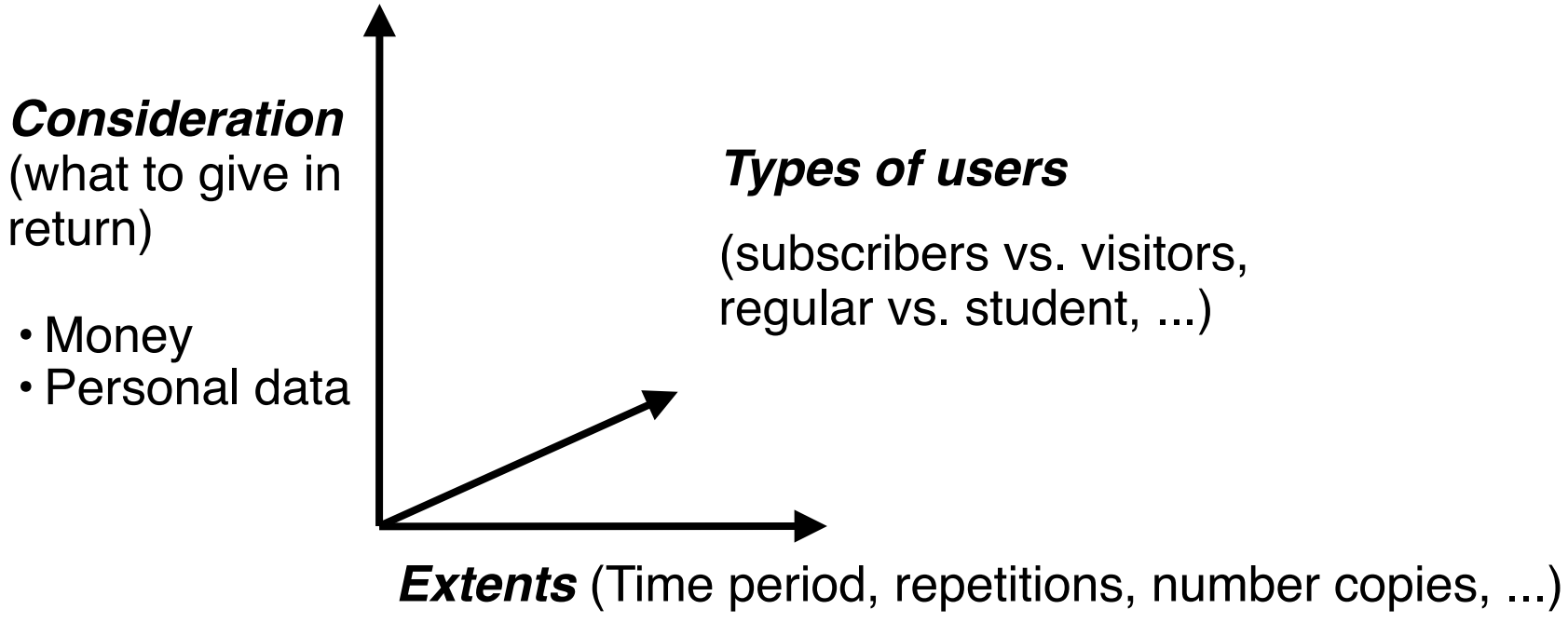
Utility Rights

- 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)

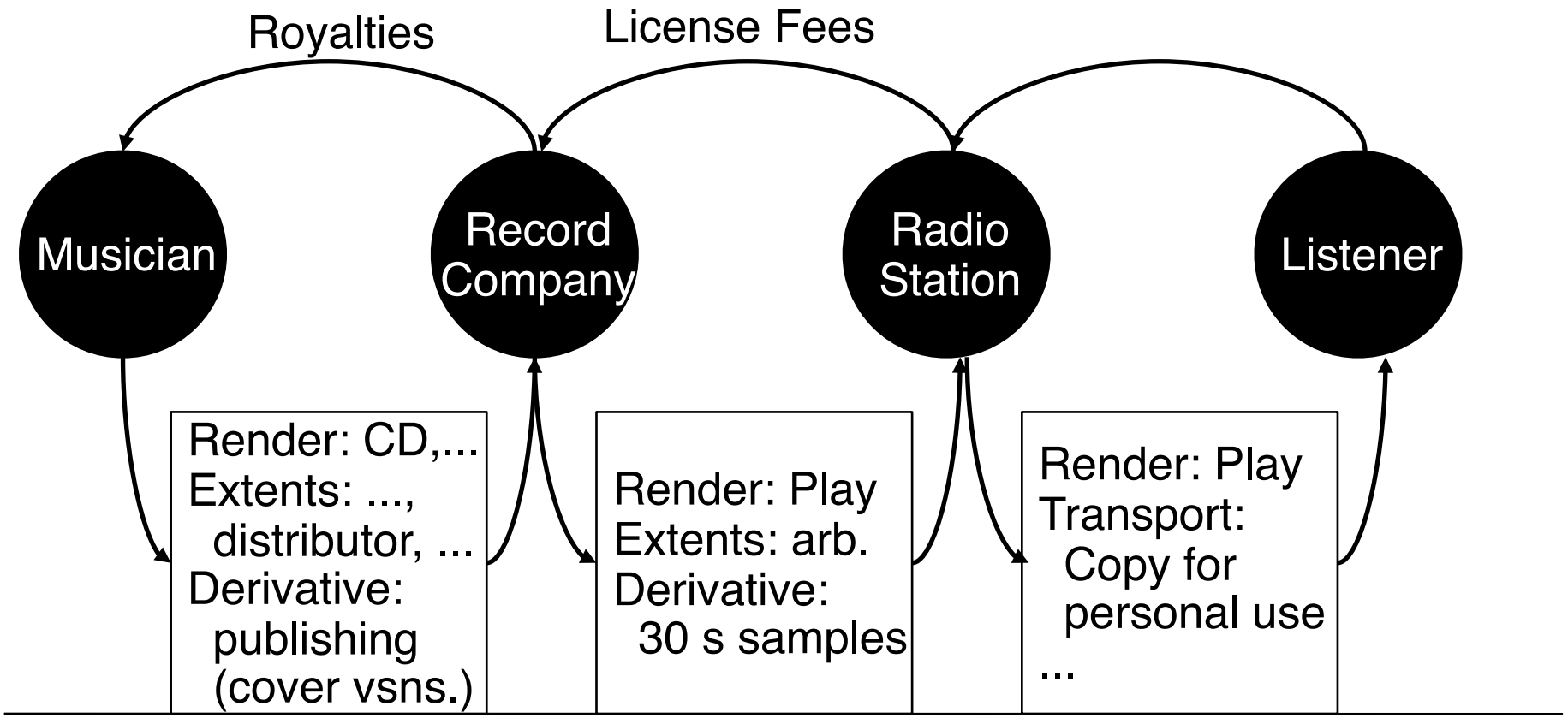
- Buying a book:
  - **Render rights:** Print
    - » Consideration: Price of the book
    - » Extent: Forever, one copy only
    - » Type of user: No distinctions
  - **Transport rights:** Sell, give away, loan
    - » No restrictions
  - **Derivative rights:** None
- Buying a cinema ticket:
  - **Render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

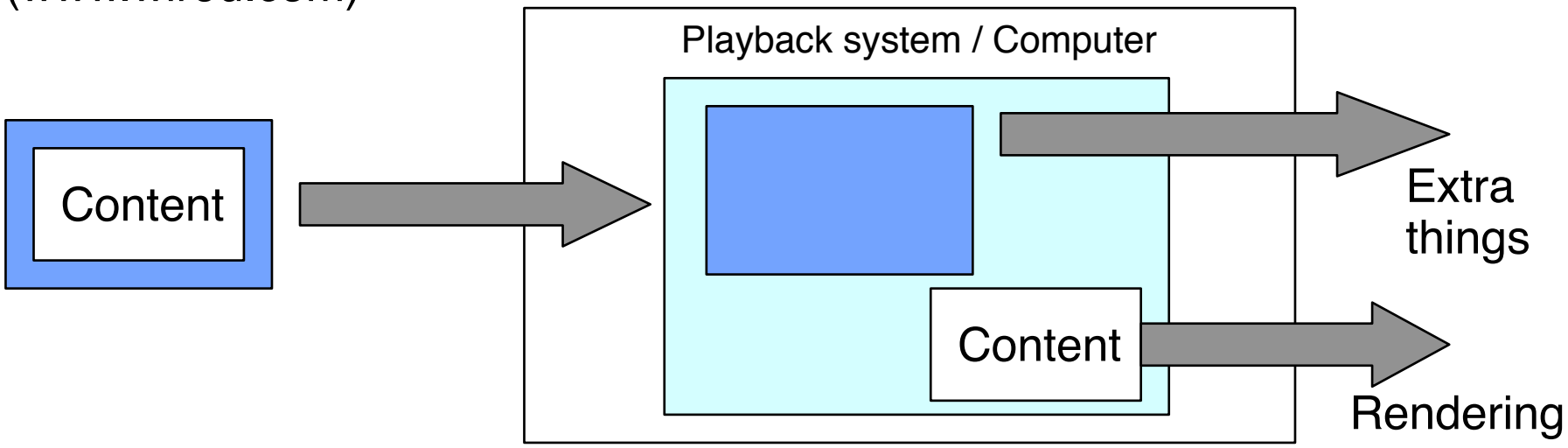
Rights Models and Digital Media

- 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)



Superdistribution for Web 2.0: Research Ideas

Deutsche Telekom Laboratories

Dr. Heinrich Arnold (links), Head of Innovation Development, und Dr. Behrend Freese, Innovation and Venture Manager, der Deutschen Telekom Laboratories. Gemeinsam mit der T-Systems und dem Zentrum für Internetforschung und Medienintegration der Ludwig-Maximilians-Universität München forschen die beiden Wissenschaftler seit 2006 an Superdistribution.

MediaNet LMU

Superdistribution 2.0

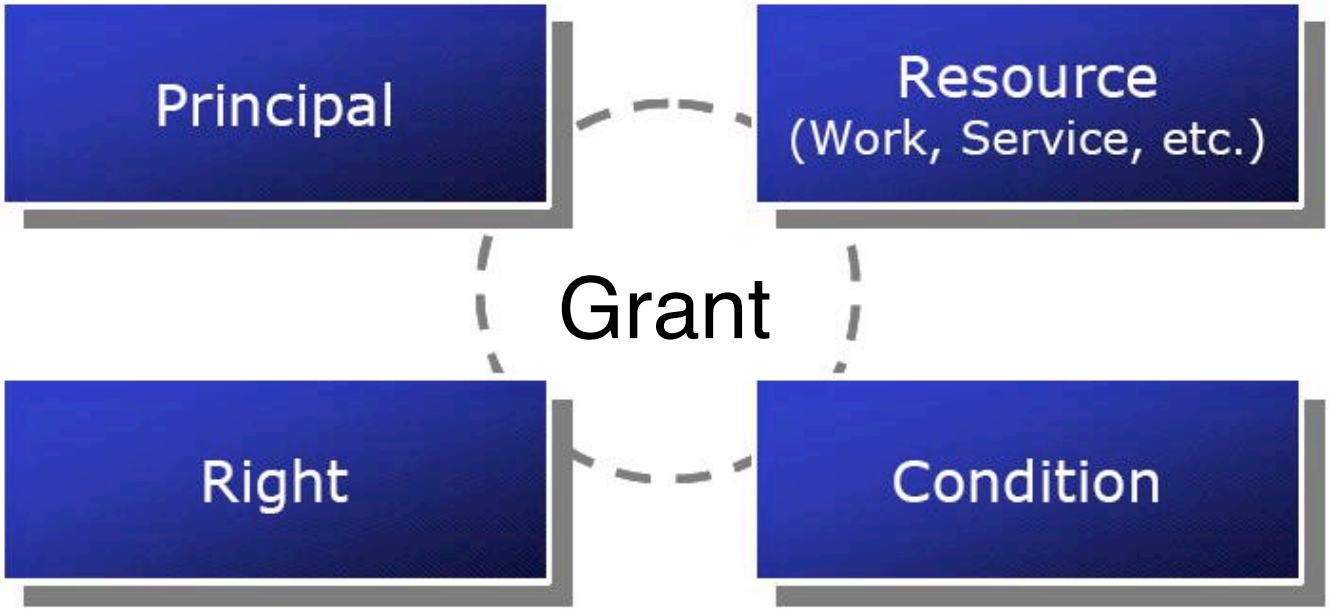
Selbst erstellte digitale Inhalte sicher in Communities verteilen

Superdistribution 2.0 demonstriert ein innovatives Geschäftsmodell, das die Superdistribution ungeschützter und rechtegeschützter digitaler Inhalte ermöglicht. Basierend auf Web 2.0-Technologien können Nutzer selbst erstellte Inhalte über Festnetz, Mobilfunk und zwischen verschiedenen Endgeräten einfach, schnell und legal an andere Nutzer weitergeben und erhalten durch die Community-Plattform Feedback zu ihren Inhalten.

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)*
    - » Current version: 2.0 (www.xrml.org)
    - » Submitted to OASIS, ContentGuard holds key patents
- Impact of XrML:
  - Microsoft implements XrML in its Unified DRM solution
  - ISO standard MPEG-21 "Rights expression language" (REL) based on XrML
  - Open eBook Forum adopted MPEG-21 REL
- Two key questions, to be separated:
  - How to *specify the rights* which are adequate in a certain situation
    - » Addressed by Rights Modeling Languages
  - How to *enforce* that the *usage* obeys the rights

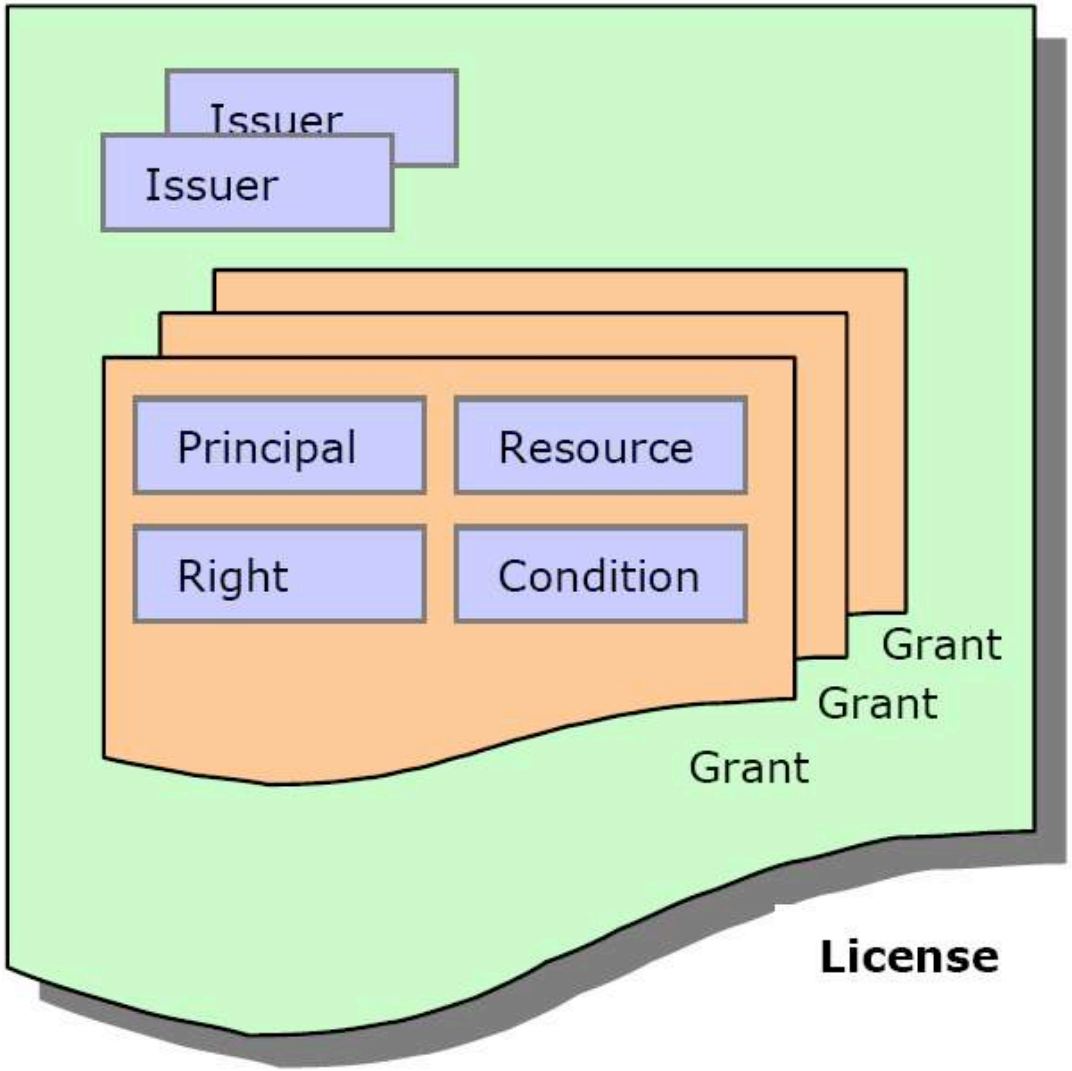
XrML Terminology: Grant



- 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, ...

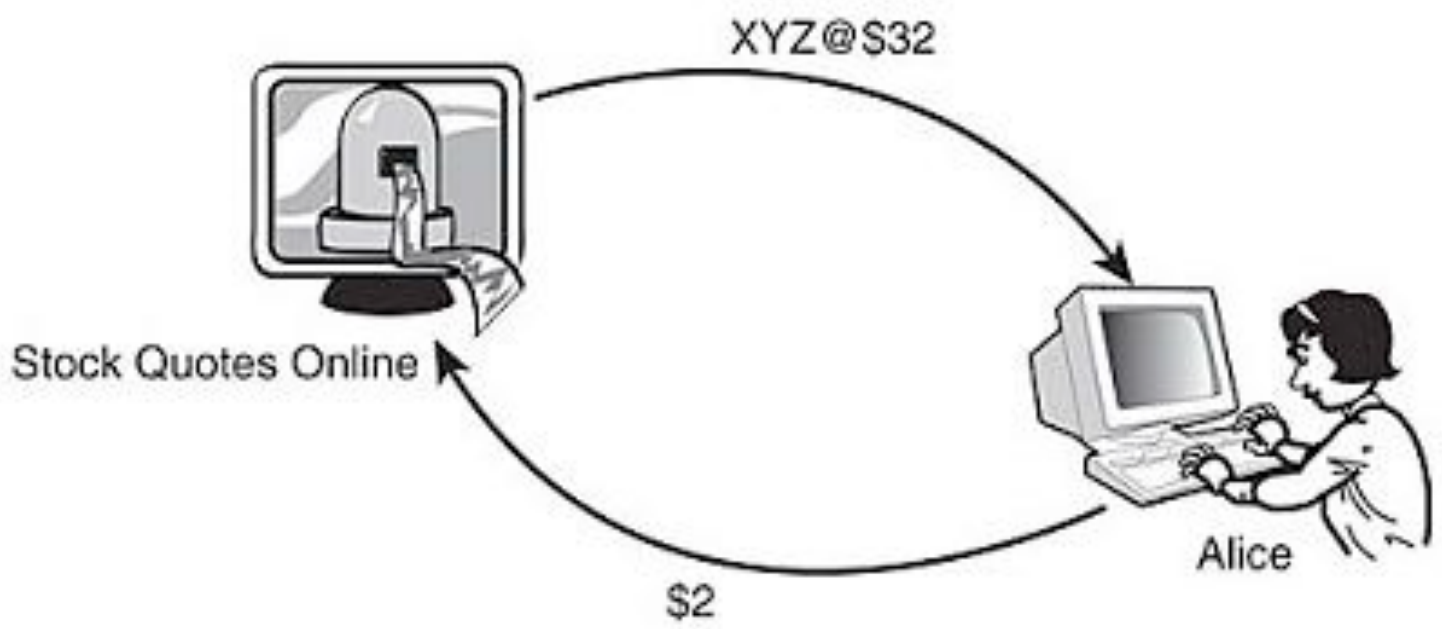
From XRML 2.0 Technical Overview

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)

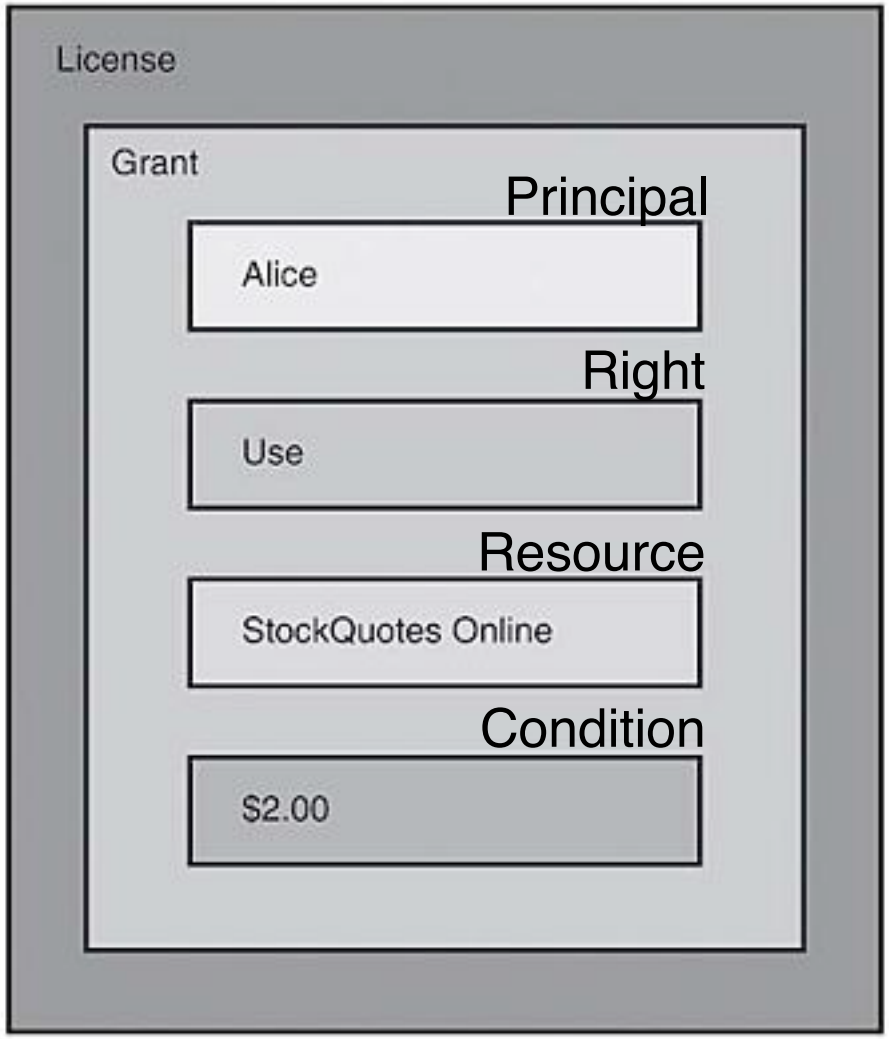
From XRML 2.0 Technical Overview

XrML Example (1)



- From: http://www.devshed.com
  (Trust, Access Control, and Rights for Web Services, Part 2)

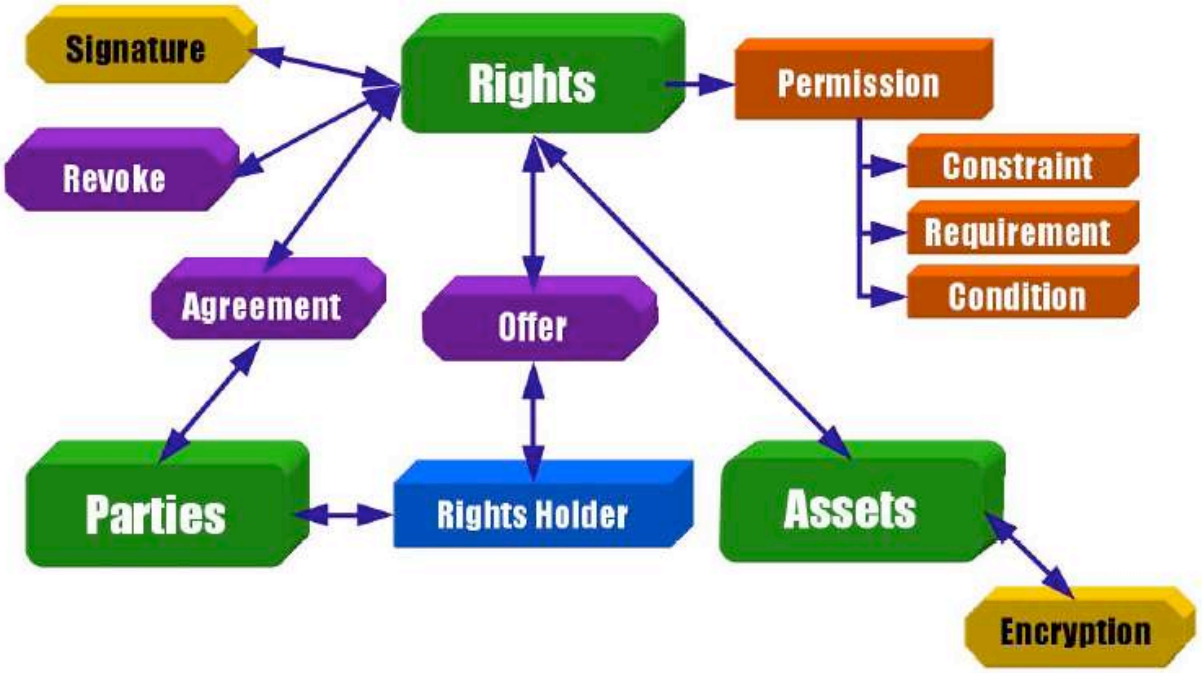
XrML Example (2)




```
<license>
  <grant>
    <keyHolder licensePartId="Alice">
      <info> digital signature </info>
    </keyHolder>

    <service:use/>

    <serviceReference>
       WSDL definition of
        StockQuotes Online
    </serviceReference>

    <sx:fee>
      <sx:paymentPerUse>
        <sx:rate>
          <sx:amount>2.00</sx:amount>
          <sx:currency>US</sx:currency>
        </sx:rate>
      </sx:paymentPerUse>
      <sx:to> payment info </sx:to>
    </sx:fee>
  </grant>
</license>
```

ODRL

- Open Digital Rights Language ODRL (www.odrl.net)
  - International initiative of various supporters (e.g. Nokia)
  - Officially accepted by the Open Mobile Alliance (OMA) (formerly known as WAP Forum)
  - XML language, standardized through W3C



ODRL Example

```
<permission>
   <play>
       <constraint>
              <container type="in-or">
                     <cpu/>
                     <storage/>
              </container>
       </constraint>
   </play>
   <requirement>
              <container type="ex-or">
                     <prepay>
                            <payment>
                                   <amount currency=”AUD”>200.00</amount>
                            </payment>
                     </prepay>
                     <peruse>
                            <payment>
                                   <amount currency=”AUD”>1.50</amount>
                            </payment>
                     </peruse>
              </container>
   </requirement>
</permission>
```

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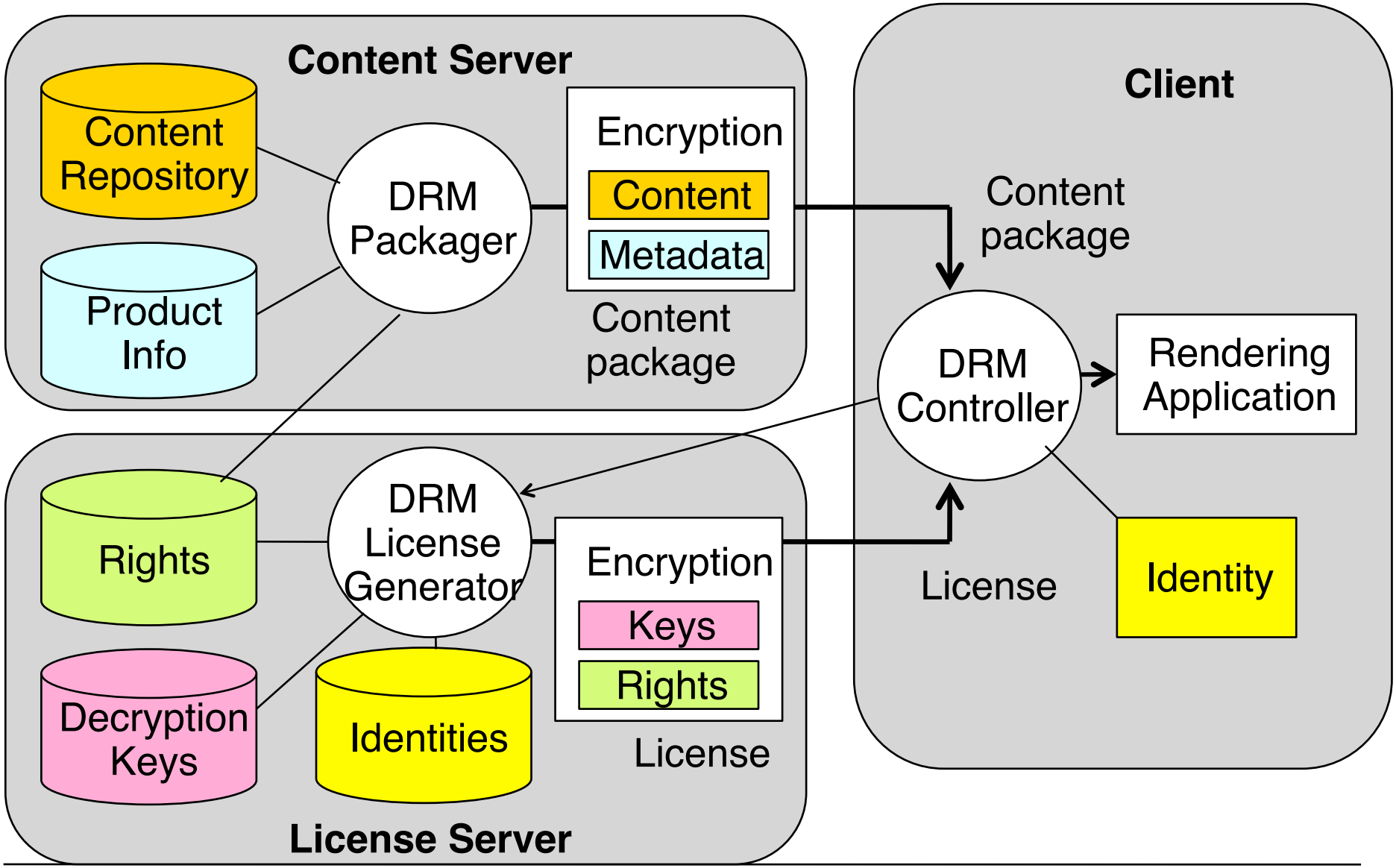
Seth Schoen: Trusted Computing - Promise and Risk, http://www.eff.org/Infrastructure/trusted_computing

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

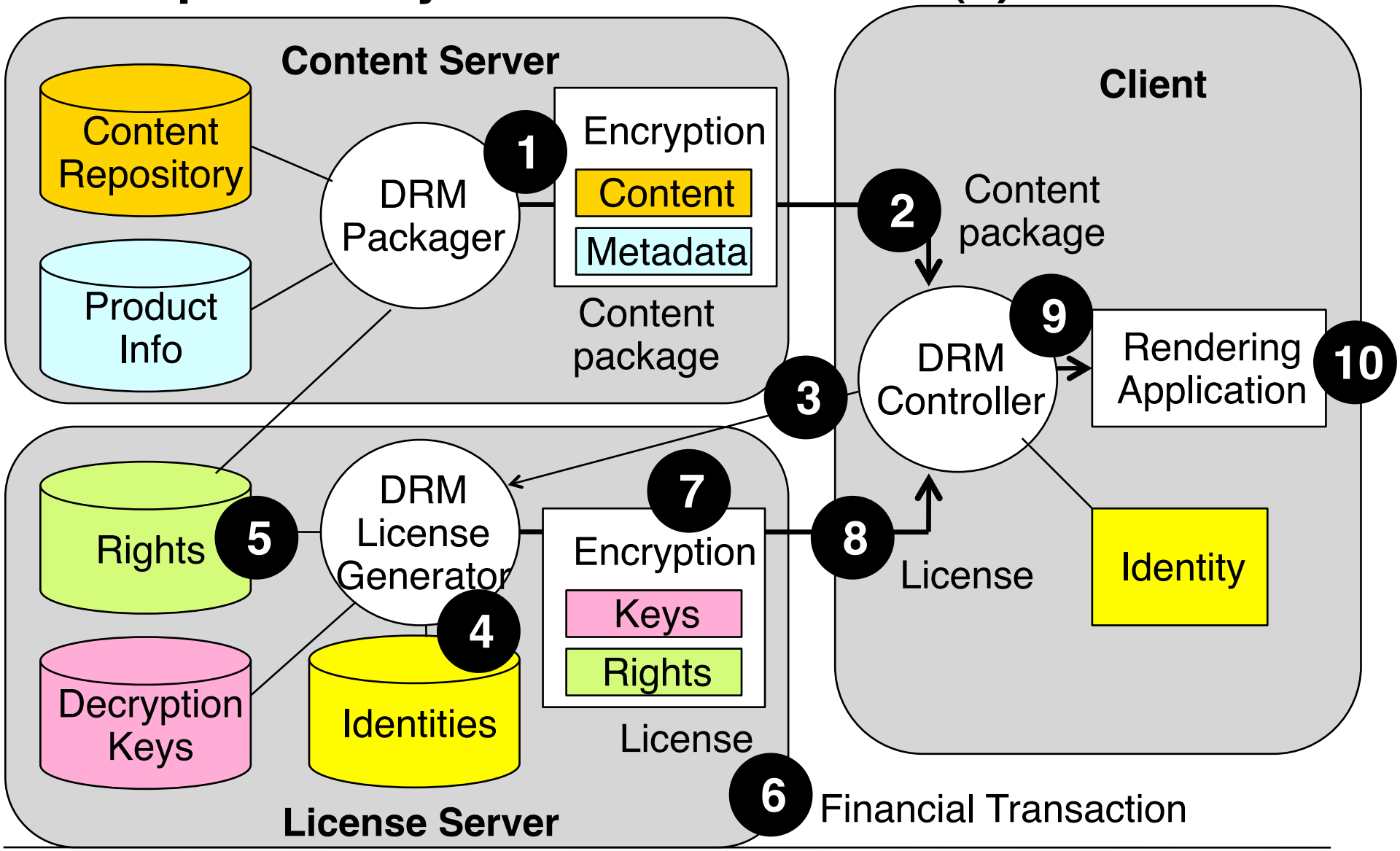
Encryption-Based DRM

- 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 organisation
  - 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 determines identity of user and content and 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 again)

(8) License is sent to the client

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

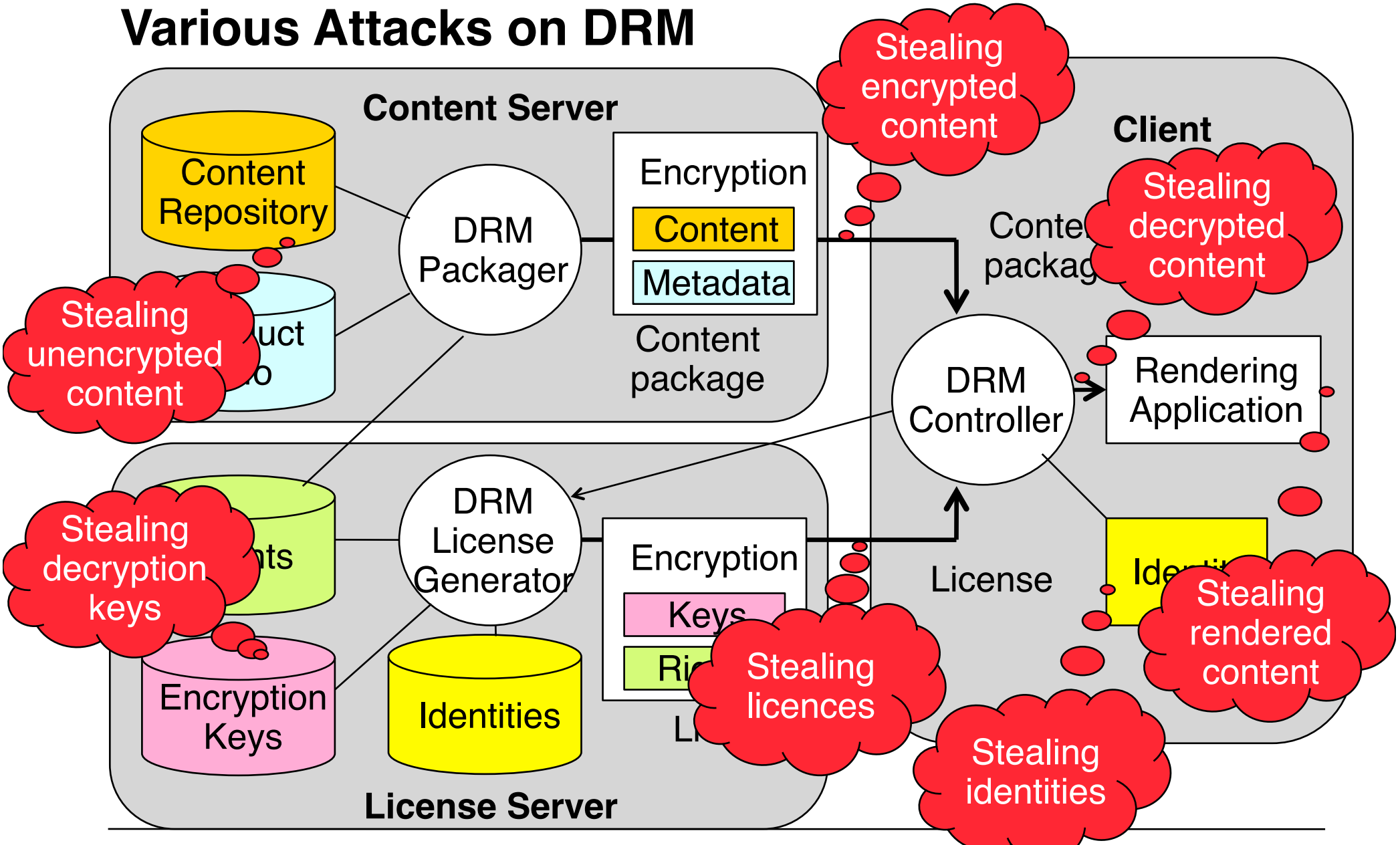
(10) Content is rendered for the user

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 (later re-named “Next Generation Secure Computing Base (NGSCB)”)
  - Bill Gates: “We came at this thinking about music, but then we realized that e-mail and documents were far more interesting domains.”

    (Quotation according to Rüdiger Weis, cryptolabs)
- “Trusted Computing Platform Alliance” (TCPA), since 2003 called “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

AMD hp invent IBM infineon intel lenovo Microsoft Sun microsystems

Key Concepts of Trusted Computing

- Endorsement key:
  - Unique key encoded in TPM hardware
- Memory Curtaining
  - Hardware-enforced memory isolation to prevent programs from reading or writing other program's memory
  - Excluding even the operating system from accessing curtained memory!
- Secure Input/Output
  - Secure hardware path to and from input/output devices
- Sealed Storage
  - Sensitive information like cryptographic keys is not simply stored but generated if authorized software runs on an authorized machine
  - Encrypted in a way including the identities of the encrypting program and the current hardware
- Remote Attestation
  - Unauthorized changes of software detectable from a remote system (before actually sending data to the suspicious system)

Pros and Cons of Trusted Computing

- Pro:
  - An effective countermeasure against threats by viruses, hackers etc.
  - Helps to ensure privacy and confidentiality of user data
  - Enables interoperability of systems over open networks
  - Respects privacy, keeps user in control
- Contra:
  - Can be misused for censorship and customer lock-in
  - Changing hardware becomes more difficult
  - Can create serious problems in case of failure (e.g. of TCM)
  - Collection and transmission of private data not transparent to users
  - Strengthens monopolies, reduces competition
  - Complicates the situation for open source software
  - Enables restrictive DRM