

Content Protection / Digital Rights Management



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November 2006

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Content Goes Digital

Analog -> Digital for Content Owners

- **Digital Threat**
 - No impediment to casual copying
 - Perfect digital copies
 - Instant copies
 - Worldwide distribution over Internet
 - And now High-Def content ...
- **Digital Promise**
 - Can protect
 - Encrypt content
 - Associate rights
 - Control usage



Conflict: Open vs. Controlled *Managed Content*

- **Avoid Morality: Applications & Technology**
 - How DRM is impacting consumer use of media
 - Awareness, Implications
- **Consumers: “Bits want to be free”**
 - Enjoy purchased content: Any time, anywhere, anyhow
 - Fair Use: Academic, educational, personal
- **Content owners: “Protect artist copyrights”**
 - RIAA / MPAA : Rampant piracy (physical and electronic)
 - BSA: Software piracy, shareware
 - Inhibit indiscriminate casual copying: “Speed bump”
- **“Copy protection” -> “Content management” (DRM)**



Content Protection / DRM *How DRM is being applied*

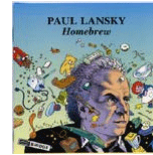
- **Consumer Scenarios: Impact of DRM**
 - Music CD Playback on PC
 - Archive Digital Music
 - Play and Record DVDs
 - Record and Edit Personal Content
- **Industry Model: Content Protection Architecture**
 - DRM Technologies
 - Protect Content
 - Manage Access
- **Next Generation of DRM**
 - DVD Video
 - AACS
 - High-Def Discs



Scenario: Play Audio CD on PC

Enjoy Personal Media on Computer

- **Plays in CD players: Home, car, portable**
- **Like to play music CD on computer**
 - Insert in PC CD-ROM drive
 - Rip copy to hard disk (legal personal use)
- **But: Some won't play in PC**
 - 1) Computer won't read disc
 - 2) Software blocks some playback / copying
- **Retrofit protection for Legacy format**
 - Original design ignored computer
 - Close the barn door



DRM: Audio CD – 1

Passive Protection: Hack the Format

- **Passive Protection: Hack the format**
 - Change the disc format
 - “Compact Disc Digital Audio” – Logo
 - Not legal CD-DA (Red Book)
 - Corrupt disc contents for computer
 - Headers, audio data
 - Multisession CD (Blue Book): Windows idiosyncrasy
- **Work-arounds**
 - Use smarter tools (Nero), Mac, Linux
 - Cover edge with tape or felt-tip marker
- **Also DVD: Sony, Macrovision rip blocking**



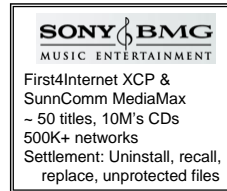
PHILIPS

See Ed Felten / Freedom-to-Tinker.com

DRM: Audio CD – 2

Active Protection: Hack the Computer

- **Active Protection: Hack the computer**
 - Modify the consumer's PC
 - Not wanted / authorized: Virus techniques
 - Installer: Windows Autorun, Before EULA
 - Hook CD driver to control disc access
 - Rootkit: Modify OS to hide files
 - Spyware: No informed consent, no uninstaller, phone home (bugs)
- **Take-away**
 - Disable Autorun: Shift key, Properties, MS TweakUI
 - Lesson?: Don't trust Sony brand, don't trust physical media
- **Enforcement: Digital Millennium Copyright Act (DMCA)**
 - Criminalizes production and dissemination of circumvention technology (1988)



Scenario: Downloaded Music

Purchase Digital Media

- **How, when, and where you want**
 - Play on computer
 - Burn to CDs, mixes
 - Download to portable devices – iPods
 - Stream across home network (PC and CE)
 - Store on multiple systems (notebook for travel)
 - Access wirelessly (mobile phone)
- **But Later ...**
 - Refuses permission to play, download, burn, etc.
 - Confusion: Which files, which permissions?
 - Missing information: Can't review, monitor usage rights
 - What about crash? How to backup, reconstruct library?



DRM: Digital Music

Content Management

- **“Content Management”**

- Goal: Walled garden within digital home
- Reasonable usage
- Invisible from inside



- **Apple FairPlay**

- Buy: Download tracks, burn, share, transfer to iPod



- **Microsoft Windows Media DRM**

- Plays For Sure
- Buy: Download and stream
- Rent: Subscribe to library



DRM: Digital Music

Issues

- **Transparency: “Invisible” until problem**

- Not paying attention, not clear how to resolve

- **Rules: Can change (iTunes)**

- Share / play on other computers (5)
- Burn playlists on CD (4/04: 10 -> 7)
- Sync with portable players (iPod only)
- Share / play on networked CE devices (0)



- **Restricted: Sharing (Microsoft Zune)**

- Share by WiFi – All music “Viral DRM”
- Play 3 times in 3 days, no re-send
- Incompatible with WM DRM



- **Archiving: Licenses (WMP 10 -> 11)**

- Manage, Recover from disaster?

- **Take-away**

- Awareness of restrictions; Open formats: MP3, eMusic

Scenario: Connect DVD to TV

Watch DVD Player on TV

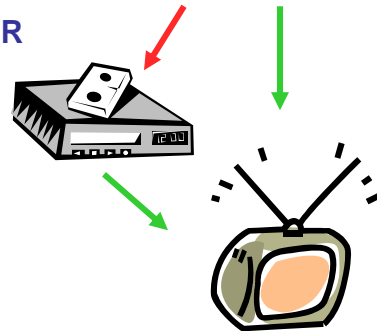
- **First DVD Player**

- How to hook up?



- **But: Can't connect through VCR**

- DVD -> VCR -> TV
- Video looks bad
- Trip to Radio Shack for A/B switch



DRM: Analog Video Copy Protect

Degrade Analog Video

- **Legacy formats: “Analog Hole”**

- Close the barn door: Hack the format
- Break engineering standard: NTSC / RS-170



- **Macrovision APS**

- Distort video signal: AGC, colorburst

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- **Issues**

- Collateral damage: Imprecise

- **Enforcement: DVD Player output**

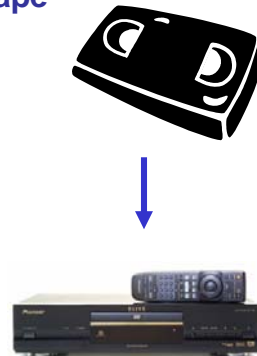
- Licensing: Format specification – to CE, portables, IT
- Legal: Criminalization through DMCA



Scenario: Preserve Old Tape

“Fair Use” Copy of Personal Media

- **Teacher wants to preserve old videotape**
 - Out of print, can't find owner / creator
 - “Fair Use” copy, backup
- **But: Can't copy on VCR**
 - Macrovision: Bad signal
- **But: Can't copy on DVD Recorder**
 - Refuses to record



DRM: Analog Video Copy Mgt

Mark Analog Video

- **Macrovision APS, part 2**
 - Copy protection: Degrade video signal
 - Plus content management flag
 - Watermark as protected
- **Enforcement: Playback / Copy Devices**
 - License: Downstream devices must respect flag
 - Legal: Broadcast Flag (FCC -> CE, IT)
- **Issues**
 - Yes/No: No gray area for “fair use”
 - Old content can be inaccessible and lost (technological and legal)
 - DVD as “good enough” DRM – can be broken



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Scenario: Create Personal DVDs

Shooting Video to DVD

- **Shoot personal videos on camcorder**
 - Transfer to CE DVD recorder
 - Author on PC, burn with DVD burner
- **But: Can't make copies of your DVD**
 - DVD recorder refuses to copy
 - PC software will not permit reuse



DRM: Recorded Media

Copy Protection for Recorded Media

- **CSS for Mastered DVDs**
 - Part of manufacturing process; coming to burners
- **CPRM (Copy Protection for Recorded Media) / VCPS**
 - Identify protected content
 - Restrict copying of protected content
 - Encryption
- **Issues**
 - Collateral damage: Personal content mistakenly marked
 - Invisible: No notification, Inspect / understand restrictions
 - Some CE devices have loopholes
- **Enforcement**
 - Licensing: DVD recorder; Download and burn: CSS for DVD
 - Legal: Broadcast Flag – WM DRM



Future Scenario: Personal Camcorder

Recording Personal Content

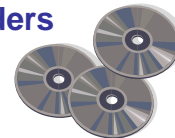
- **Shoot personal event with personal camcorder**
 - At home: TV / music playing in the background
 - Public venues: Background activities
- **But: Can't record, play back, copy**
 - DVD recorder refuses to copy
 - Camcorder refuses to record
- **All content watermarked**
 - Recorded, broadcast, etc. flagged as protected
 - CE devices check and conform



Content Protection Technologies

Stored on Physical Devices

- **Content Protection on Media – DVD, H-D DVD Players**
 - CSS - Content Scramble System – DVD-Video [DVD CCA]
 - CPPM - Content Protect for Pre-recorded Media (DVD-Audio) [4C]
 - Sony DADC ARccOS, Macrovision RipGuard DVD
 - AACSS - Advanced Access Content System – H-D DVD [AACSS LA]
- **Copy Protection for Blank Media – DVD Recorders**
 - CPRM - Content Protection for Recordable Media [4C Entity]
 - VCPS - Video Content Protection System- DVD+RW [Philips, HP]
 - Recordable CSS – 2007
- **Copy Management – Analog – DVD Recorders**
 - CGMS-A - Copy Generation Management System
 - CGMS-D - Digital
 - Verance Watermarking – DVD-Audio, H-D DVD



Transmission Protection Tech

In Transit Between Devices



- **Transmission Protection – Analog**
 - Macrovision ACP / (APS) – Analog Protection System (DVD)
 - Broadcast Flag [FCC]
- **Digital / Network Transmission Protection**
 - Windows Media DRM, etc.
 - DCPS - Digital Copy Protection System -> DTCP [5C]
 - DTCP - Digital Transmission Content Protect (1394, IP) [5C/DTLA]
 - DTCP-IP - DTCP over IP [5C/DTLA]
- **HD Transmission Protection**
 - DVI - Digital Visual Interface (PC) [DDWG]
 - HDMI - High-Definition [Digital] Multimedia Interface (CE, w/ audio)
 - HDCP - High-bandwidth Digital Content Protect - DVI / HDMI [Intel]
- **Interop Standards: Coral, Marlin, OMA (Open Mobile)**



Content Protection Architecture

CSPA – Formal architecture, Overall framework

- **CPWG – Copy Protect Working Group, 2/2000**
 - 11 Axioms – 4C Entity: www.4centity.com
- **Guard against casual copying**
 - “Keep the honest people honest” / Can't stop well-equipped pirates
- **Mark and protect content – Compliant devices**
 - Manage with watermarking (Copy Control Info)
 - Protect transmission / analog and digital outputs
- **CPSA – Content Protection System Architecture**
 - Conditional Access (Internet, Cable) – WM DRM
 - Protected Distribution (DVD, HD) – CSS, AACS, Watermark CMI
 - Protected Storage (Recordable Disc) – CPRM, AACS
 - Protected Transmission (Display, Network) – APS, HDMI, DTCP



CPSA Architecture

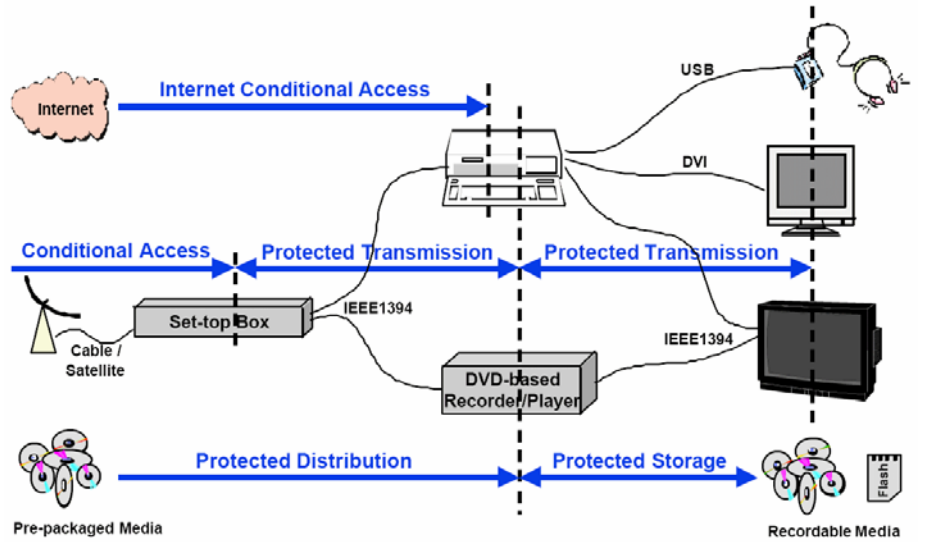


Figure 1. Digital Content Protection Chain

DVD Content Protection

License requirements for current DVD-Video

- **Content protection**
 - **Creation:** CSS encryption, Macrovision, CGMS flag, CPPM DVD-Audio
 - Optional for disc producer: Don't need to protect your content
 - **Playback:** CSS decryption optional (hardware and software)
 - Don't need to play protected content
 - **Computers** and DVD-ROM drives: CSS, Macrovision, CGMS required
 - **DVD recorders:** CPRM, optional
- **Transmission protection**
 - **Access:** Secure connection between drive and decoder hardware
 - **Analog** Video (PC video cards with TV outputs): Macrovision required
 - **Digital** video output:
 - IEEE 1394/FireWire data: DCPS (DTCP) required
 - HDMI (DVI) video: HDCP required
- **Regional Codes**
 - Authorize playback in 7 geographic locales or zones
- **Parental Management**
 - Block play, or alternate versions



Next-Gen DRM: AACCS

Content management for Blu-ray and HD DVD

- **AACS – Advanced Access Content System**

- AACS LA, www.aacsla.com
 - IBM, Intel, Microsoft, Panasonic, Toshiba, Disney, Sony, Warner
- Next-gen prerecorded and recorded optical media
- CE and PC devices, Home networked environment
- Used for Blu-ray and HD DVD – New business models
- Content management: CSS + CRPM
 - AES 128 bit encryption
 - Enhanced Drive Authentication – Device key for drive
 - Improved Media Key Block – Precise key revocation
 - Disc manufacturer ID bound to key – Authenticate original
 - Network connectivity – Unlock content by Internet



High-Def DVD Content Protection

Requirements for HD DVD and Blu-ray

- **Content management: AACCS – Advanced Access Content System**
- **Transmission protection: DTCP, HDCP, WM DRM-ND**
- **Playback control: Verance audio watermark**
- **Revocation: Media Key Block and Content Revocation List**
 - New content updates list of revoked equipment
- **Renewal requirement**
- **Analog output constraint flags**
 - ICT (Image Constraint Token): Limit image resolution
 - Digital Output Only Token: Disable all analog video output
- **Analog sunset provisions**
 - Disable HD analog video output (12/2011), all analog output (12/2013)
- **Final AACCS license adds:**
 - Managed Copying, Digital Output Only Token, Audio Watermark detection
- **Blu-ray adds**
 - BD+ renewability, ROM-Mark disk ID



Key Issues

DRM Impact on Consumers

- **Range of Application**
 - Digital & analog, Physical & electronic, Original & copies
- **Usage Restrictions**
 - Access, copy, share, download, backup; License & Legal
- **Renewability**
 - Change / revoke existing usage
- **Collateral Damage**
 - No gray area (fair use), Side effects, Lost content
- **Risk: Consumer and industry**
- **Disclosure: Transparency of walled garden**



For More Information



The Manifest Technology site by Douglas Dixon contains over 200 articles and technical references on multimedia technology, especially digital video editing and DVD authoring.

