VWM Companies' Watermarking Technology

A Presentation to the Analog Reconversion Discussion Group by Macrovision,

Licensing Agent for the Joint Solution of the VWM Companies

April 10, 2003

Digital Watermarks Defined

Digital watermarks are data embedded within the content, not in the header, which electronic devices can read but humans cannot perceive

Original Image | Digital Watermark-enabled | Exaggerated view

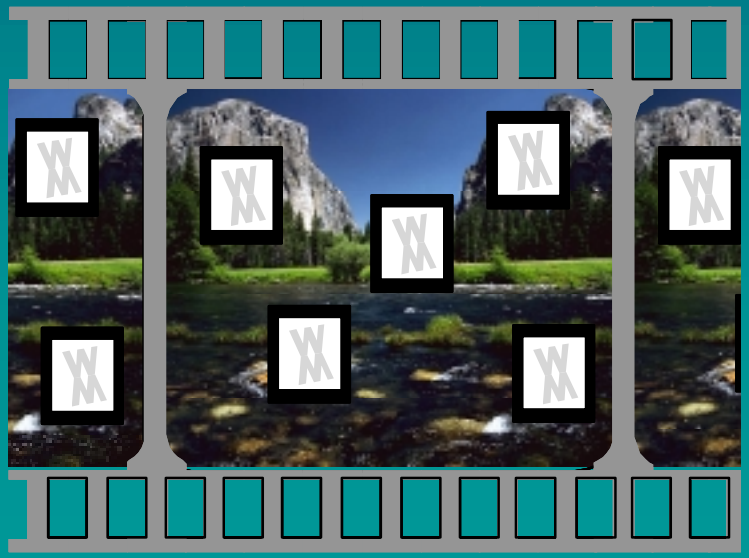
- **Persistent digital identity for media content, that survives Analog to Digital and D to A transformations**
- **Watermarking has been broadly deployed and adopted**
  - **Images, Print, Audio, Video**
  - **Billions of watermarked objects and millions of readers in market today**

Some Relevant Watermarking Applications

- **Copy Control**
  - Communicates desired behavior of consumer's device
  - Conveys Copy Control Information in a robust manner to control copying of protected digital commercial content
- **Forensic Tracking**
  - Identify unauthorized leakage to consumers from prerelease to manufacturing and promotion
  - No cooperation required of consumer's devices
  - Allows rights holders to take legal or business actions against sources of leaks
  - Being used by most major record labels
- **Broadcast and Internet Monitoring**
  - Watermark identifies where the content has been distributed and reports back to content owner
  - Adopted by *Reuters* and *NBC News Channel* for Video; *Coca Cola* for advertising; and commercial photographers, *Corbis*, and other stock agencies for Images
- **Content Identification and Asset/Rights Management**
  - Communicate copyrights and facilitate licensing
  - Link to DAM, DRM, content enhancement and e-Commerce systems
  - Has been widely deployed in Adobe Photoshop and other image editing applications and adopted by thousands of companies and imaging professionals

What is Video Watermarking?

- **Robust & imperceptible information hidden within video content itself**
  - **Robust – Survives common transformations that would be performed by a consumer or consumer equipment**
    - **Digital -to- analog video -to- digital conversion**
    - **MPEG compression for storage for time-shifting**
    - **VHS copying for time-shifting**
  - **Imperceptible – Not visible in a consumer's viewing environment**



Key Benefits of Video Watermarking

- Survives format and interface changes
- Uses existing and emerging network infrastructure
- Minimal impact on existing workflow and production costs
- Can be effectively integrated with a variety of devices
- Plugs the Analog Hole by retaining copy control information (CCI)
- Security and enhancement layer
  - Analog and Digital content

Watermarking Plugs the Analog Hole

"One way to plug the analog hole is through the use of watermarks…. some government action will be needed to require appropriate detection of and response to the watermark."

Richard Parsons, CEO, AOL Time Warner, Inc. Senate Judiciary Hearing, March 14th, 2002

"Watermarks may provide a means to ensure that protection rules survive as content transitions analog outputs."

Dr. Craig R. Barrett, President and CEO, Intel Corp. Senate Judiciary Hearing, March 14th, 2002

"We are developing a plan to plug the "analog hole" that includes harnessing watermarking technology that would prevent such conversions from being used to avoid content protection obligations"

Peter Chernin, President and COO, News Corporation Senate Commerce Committee Hearing, February 28th, 2002

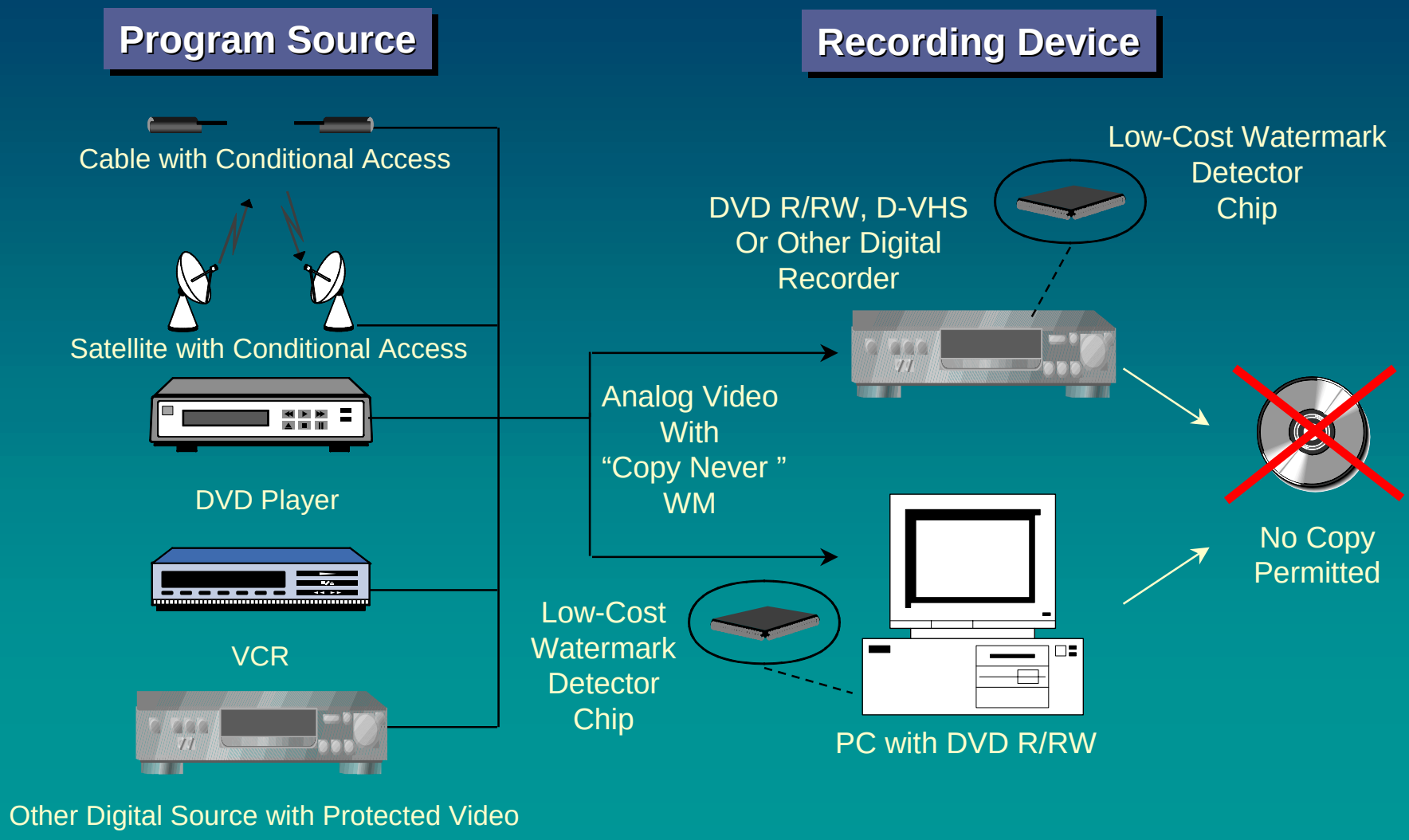
"Watermarking is one of the most promising techniques for protecting the content owner's rights of a digital good"

Microsoft US Patent Application, 20030009671 Filed April 23, 2001

Watermarking Benefits for Content Protection Applications

- **Record Control**
  - **Prevent** recording of video that is sourced from DVD, or PPV (“**Copy Never**”)
  - **Allow** recording of video for time-shifting from pay TV or subscription television services, such as HBO (“**Copy One Generation**”)
    - **Prevent** further copies of first copy (“**No More Copies**”)
- **Play Control**
  - **Prevent** playback of unauthorized copies of watermarked video
- **Communication of Restrictions on Redistribution**
  - **Identify** analog video that was derived from **protected** digital video

System Overview - Record Control with "Copy Never" Watermark



System Overview - Record Control with "Copy One Generation" – 1st Gen

Program Source

Recording Device

Cable with Conditional Access

Satellite with Conditional Access

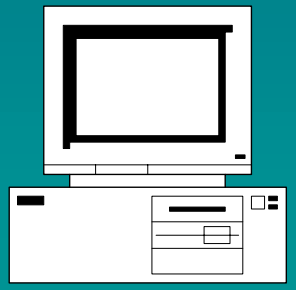
Other Digital Source with Protected Video

Analog Video With "Copy One Generation" WM

Low-Cost Watermark Detector & Remarker Chip

DVD R/RW, D-VHS Or Other Digital Recorder

Copy Permitted, but Marked with "No More Copies" WM



PC with DVD R/RW

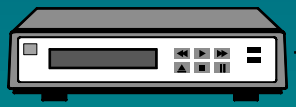
Low-Cost Watermark Detector & Remarker Chip

System Overview - Record Control with "Copy One Generation" – 2nd Gen

Program Source

Recording Device

Recordable Disc Marked with "No More Copies " Permitted

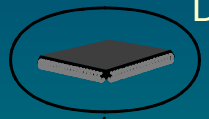


DVD Player

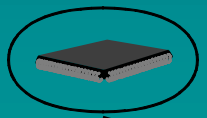
Analog Video With "No More Copies" WM

DVD R/RW, D-VHS Or Other Digital Recorder

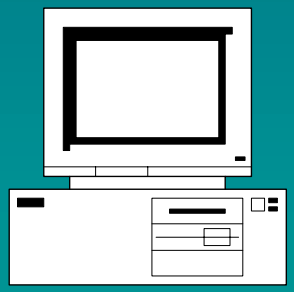
Low-Cost Watermark Detector & Remarker Chip



No Copy Permitted



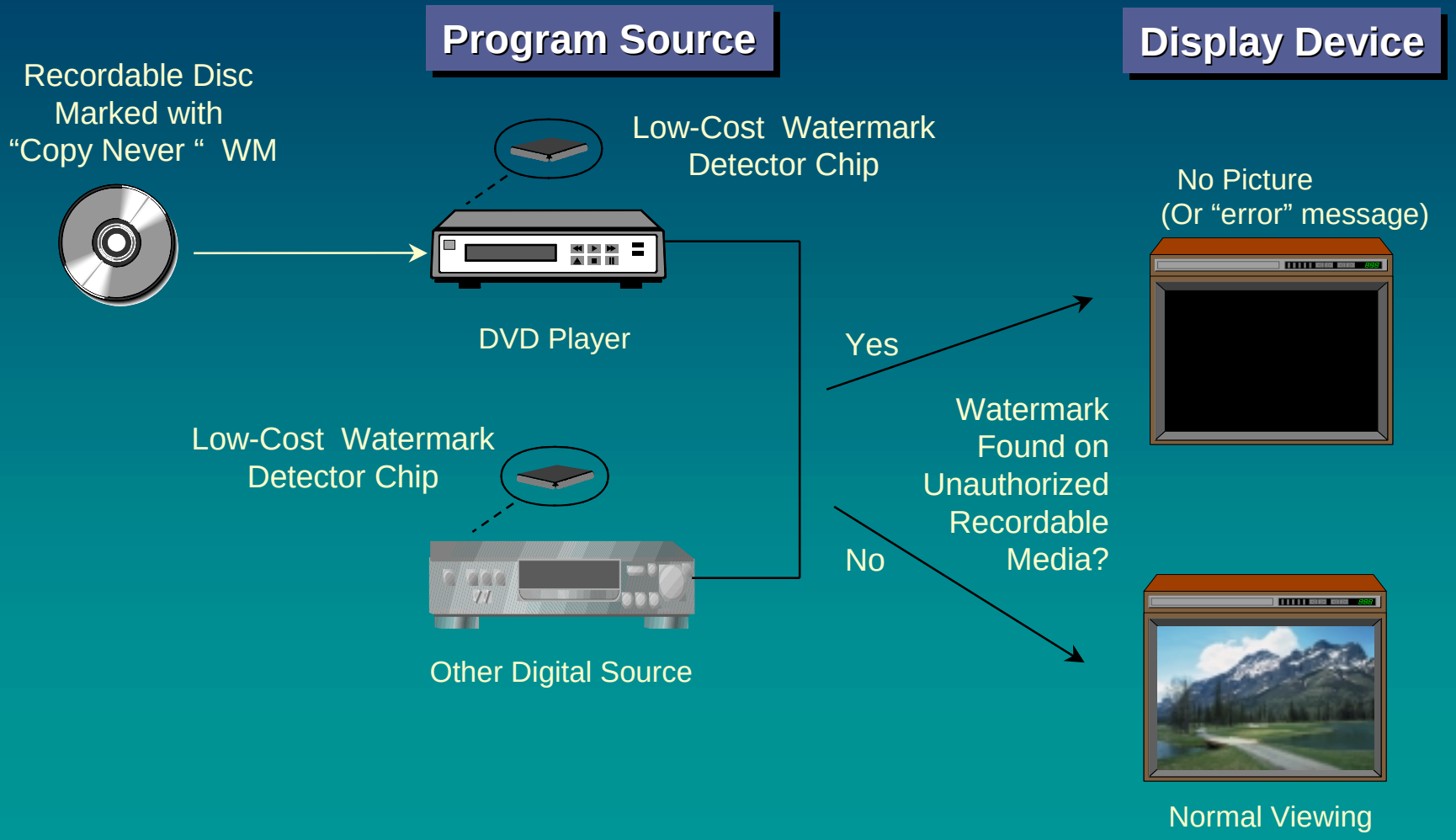
Low-Cost Watermark Detector & Remarker Chip



PC with DVD R/RW

System Overview - Play Control

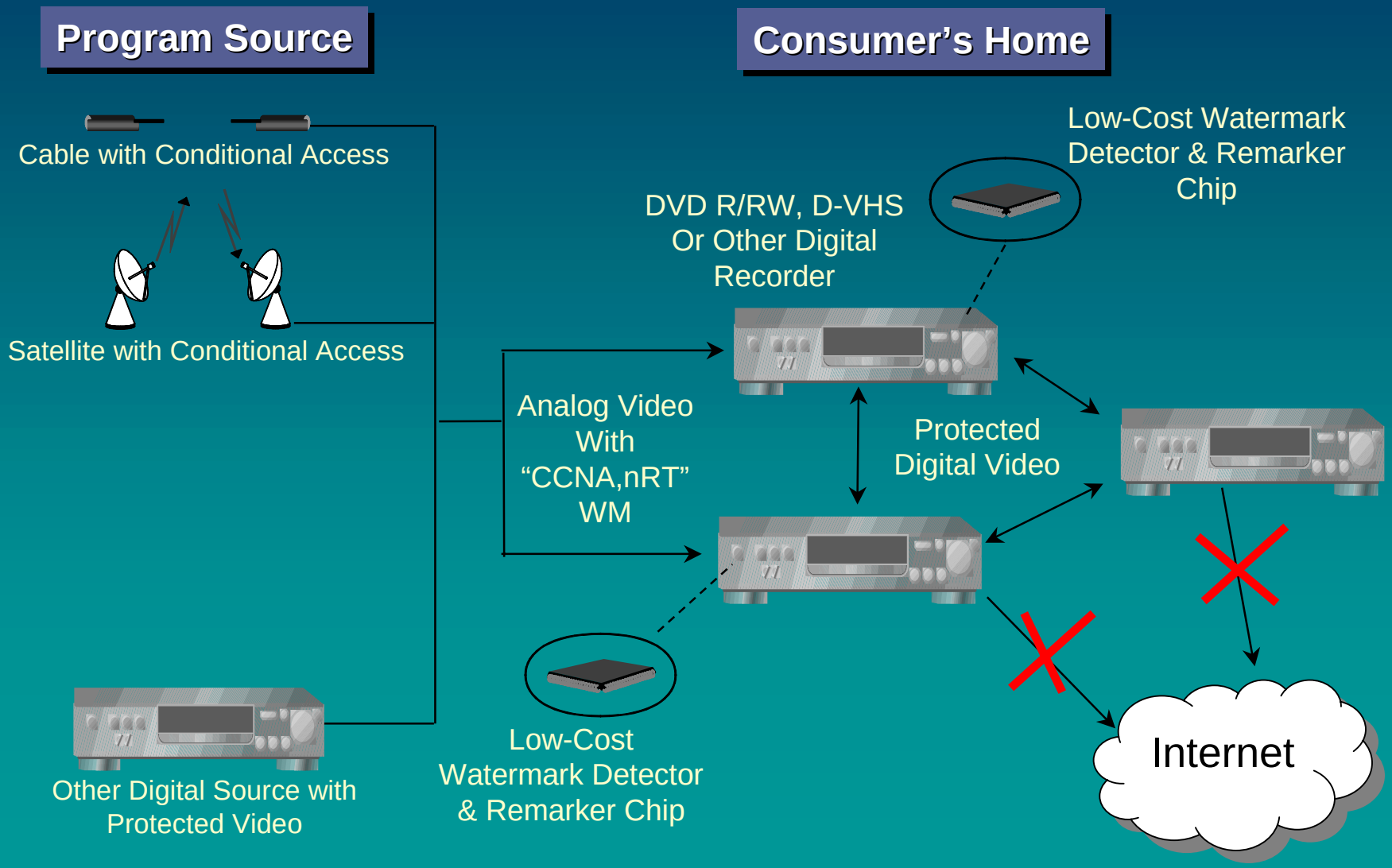
- **Backup to record control**



System Concept

"Copy Control Not Asserted, no Re-Transmission"

- **Redistribution protection is triggered when WM detected**



Elements of License & Specification Rights Holders

- **Available Now to Rights Holders**
  - **Professional equipment: embedding & verification**
    - **Real-time video encoding**
    - **Serial digital video input and output (270 Mbps)**
    - **525 and 625 operation**
    - **1 rack unit chassis (19” x 1.73” x 12”)**
    - **PC control via Ethernet**
    - **Broadcast monitoring variant of professional equipment installed at many locations worldwide**
  - **Licenses & Pricing**

Features of VWM Watermark Technology

- **Low Cost** to End Product / Hardware Manufacturers
  - Costs **acceptable** to major manufacturers of consumer devices
  - Gate count, memory and MIPs :
    - **Small fraction** of that required for **existing functions**
    - **25K** – 45K Gates **+ 72 KB RAM**
      - Depends on function: **baseband / MPEG** and **detect / remark**
    - DSP & PC benchmarks available
      - Requires identification of many assumptions
      - Allows for optimization
  - Technical Support Costs to End Product Manufacturers
    - **No unexpected support costs**
    - Mathematically modeled false positive probabilities
    - Extensive testing to validate models on 3 separate occasions by independent test organizations
    - Watermark prevents consumer action only when appropriate
  - Significant **intellectual property** position
    - Designed to minimize need for 3rd party IP, e.g. MPEG-LA

Extensively tested by multiple companies for cost effective implementation

Features of VWM Watermark Technology (2)

- **Robust**
  - Conversion to analog and back to digital
  - Horizontal and vertical image shifts
  - Standards conversions
    - NTSC to PAL and vice versa
  - Multiple VHS generations
  - Filtering
  - Scaling of the video
    - Independently and arbitrarily in both horizontal and vertical directions
  - Color correction
  - MPEG-2 compression at wide range of bit rates and low resolutions
    - Three serial encode/decode cycles
  - Cropping
  - Combinations of the above

Extensively tested by multiple companies for robust and reliable implementation

Features of VWM Watermark Technology (3)

- **Payload Capability**
  - Detector able to detect 28 bits
  - Easily able to support 5 usage states described by MPA
- **Perceptibility**
  - From independent test organizations performing double blind tests:

"None of the viewers considered the watermark even mildly annoying"

"The MPEG artifacts overwhelmed watermarking"

Features of VWM Watermark Technology (4)

- **Possible PC Locations**
  - In-the-DVD recordable drive
    - Technology robust against
      - random reads
      - multiple applications accessing drive
  - Video Capture Card
  - Secure software

- **Generational Copy Control**
  - "Copy One Generation" watermark triggers adding secondary watermark to video in remark module
  - Secondary watermark defines "No More Copies"
  - Remarking modules available:
    - C and VHDL
    - MPEG and baseband versions

Comparison of Video WM to Other Technologies for ARDG Purposes

- **Signaling Systems**
  - **CGMS-A**
    - More limited payload and usage state information
    - Cheapest to circumvent
    - Much less robust
  - **Analog Protection System**
    - More limited payload and usage state information
    - Cheaper to circumvent
    - Less robust in many environments
    - Provides additional protection against VHS copying
- **Audio Watermark**
  - **Unable to independently provide protection to video**

Conclusion

- Video watermarking addresses primary concerns of ARDG
- Single technology works in digital and analog domains
- Core technology has ancillary benefits for rights holders and consumers
- Available today for protecting high value video content
- Extensively tested and proven
- Supported by leading consumer electronics manufacturers