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HIDE Technology Video Watermark for CCI and Forensic Purpose

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HIDE: Human eye Insensitive Digitally Embedded watermark

Outline

- **Overview of HIDE Technology**
- **Background**
- **Piracy Model**
- **System Model**
- **Demonstration**
- **Conclusion**

Overview of HIDE Technology

- **In 2001, HIDE was proposed in response to DVD CCA's "Request for Expressions of Interest" for watermark and met the requirements**
- **Features**
  - Robustness against various kinds of operations and attacks
    - Especially, robust against scaling and filtering
  - Low false positive error rate
    - Meet DVD CCA's requirement
  - Good transparency
  - Sufficient capacity for copy control usage
  - Baseband detection, independent from the compression methods and formats

Robustness/Survivability

- **Robust against various kinds of attacks:**
  - Vertical and/or horizontal scaling
  - MPEG-2/MPEG-4 compression and decompression
  - VHS recording
  - D/A and A/D conversions
  - Random noise addition
  - Gamma correction
  - Jitter attack
  - Rotation attack
  - **Camcorder piracy**

Robustness

- **Rotation**

Robustness

- **Keystone**

Robustness

- **Keystone (horizontal)**

Transparency

- **Sophisticated adaptation based on characteristics of the original image for decreasing artifact caused by the watermark image**
- **Any annoying artifact can hardly be perceived in the watermarked image**

Capacity

- **16 bits per several minutes**
  - Can include both CCI and forensic information
  - Can be expanded to almost infinite combinations by changing the embedded information in a certain time
    - If the movie is 80 minutes long and the embedded information varies every 20 minutes, 4 kinds of information can be embedded

      (i.e. (2^16)^4 = 2^64 combinations!!!)

Background

- **Threat by camcorder piracy is growing**
  - Camcorders supporting HD resolution are increasing

    → HD camcorder piracy is possible at theater

  - HD content is provided by broadcasting or next generation optical disc
  - LCD and PDP support full HD resolution

    → HD camcorder piracy is also possible at home, which is difficult to prohibit

Easy to create HD (or high quality) piracy content

Comparison of Captured Image (CRT, PDP, LCD)

CRT
PDP

LCD

HD Source Image

HD Display → HD Capture

SD Source Image

SD Display → HD Capture

HD Source Image

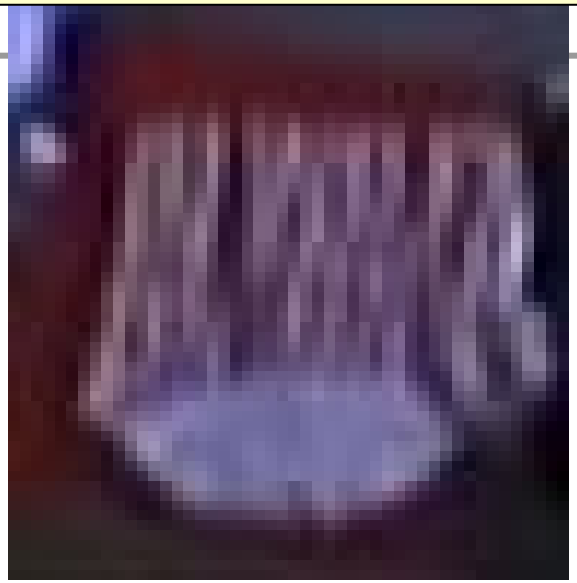
HD Display → HD Capture

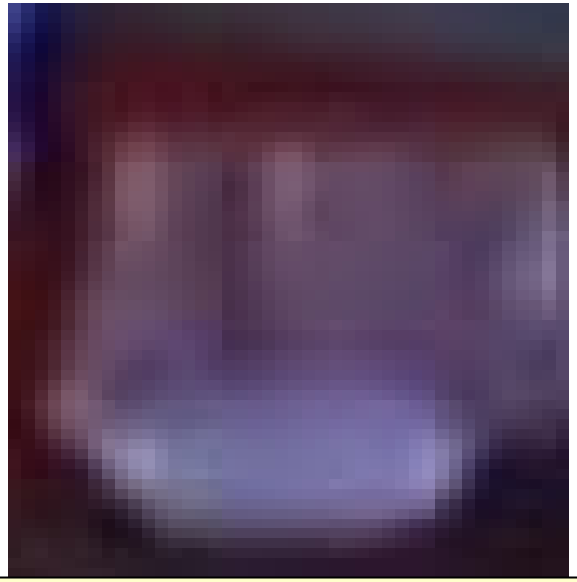
SD Source Image

SD Display → HD Capture

HD Source Image

HD Display → HD Capture

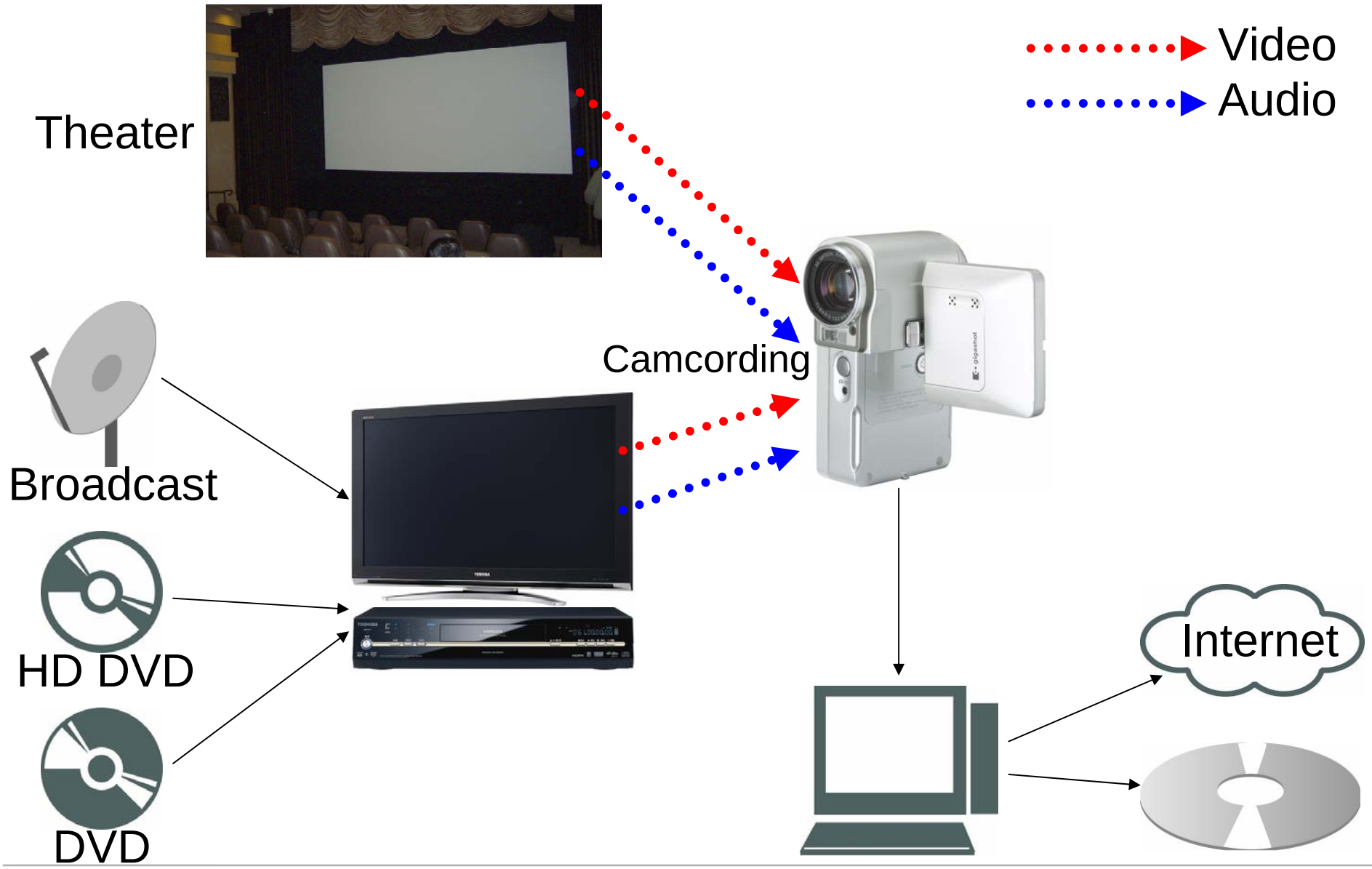




SD Source Image

SD Display → HD Capture

Piracy Model



Quality of Illegitimate Content

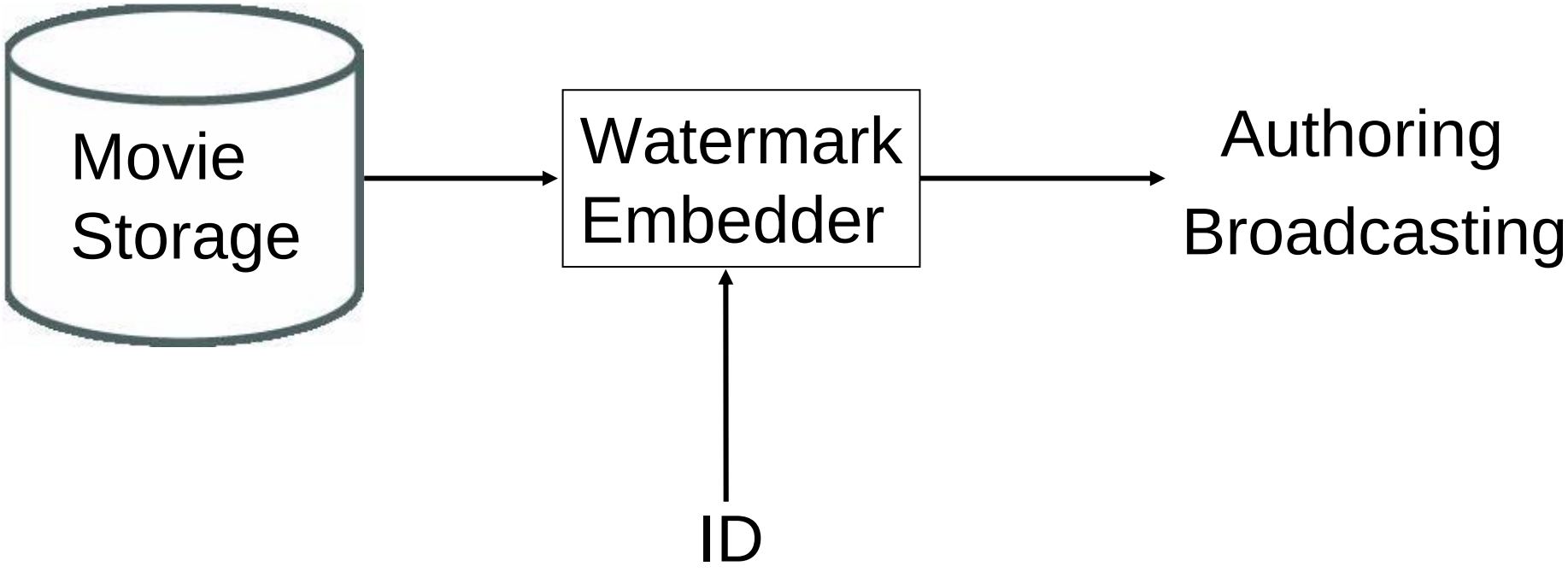
Source			Video			
			Camcording			
			Theater	HD DVD	DVD	Broadcast
Audio	Camcording	Theater (WM)	HD *Fair*	HD *Fair*	SD *Fair*	HD *Fair*
		HD DVD (WM)	Available after releasing movie			
		DVD	HD Good	HD Good	SD Good	HD Good
		Broad-cast	HD Good	Available after releasing DVD / HD DVD		

What can be Achieved by Forensic and CCI Watermark?

- **Identify the theater where camcorder piracy was made**
  - Precise identification of the specific theater can be made when used for forensic purpose
- **Playback control against piracy can be introduced**

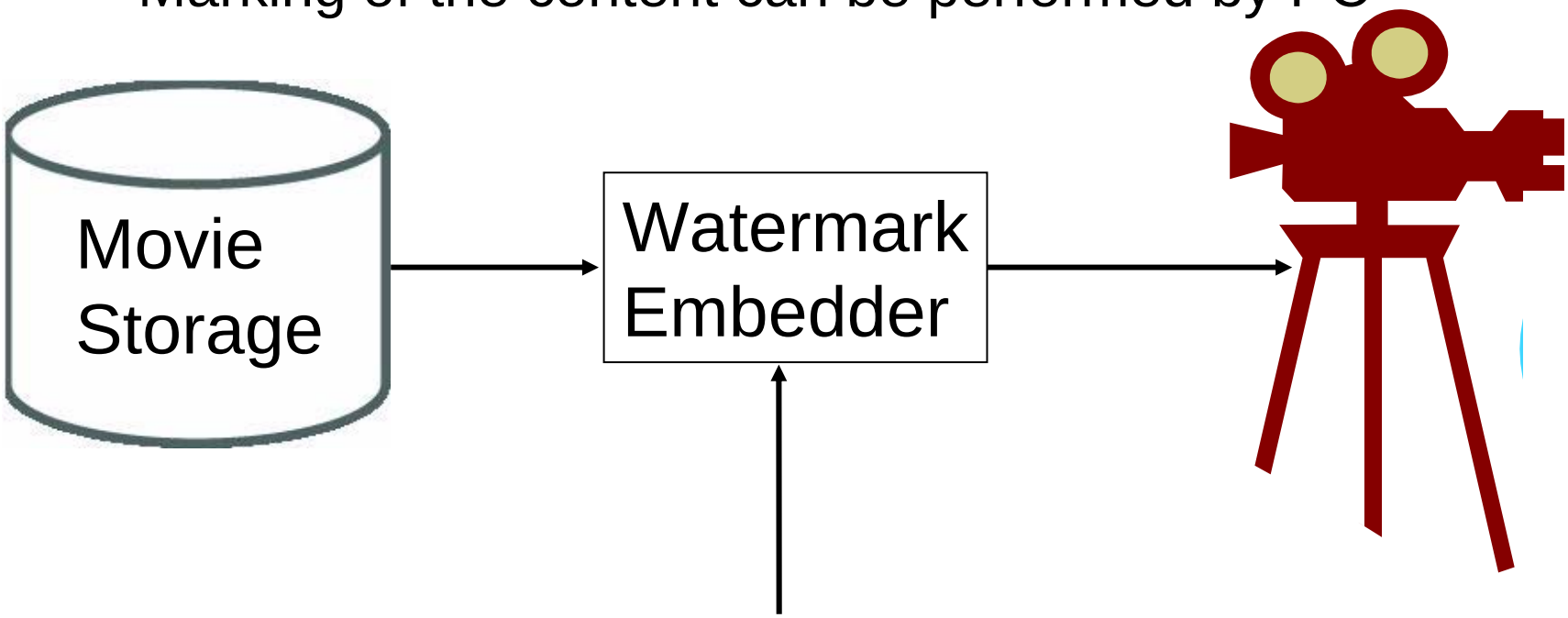
System Model for Marking (HD DVD, DVD, Broadcast)

- **Mark the content on-the-fly or off-line**
  - Marking of the content can be performed by PC



System Model for Marking (Digital Cinema)

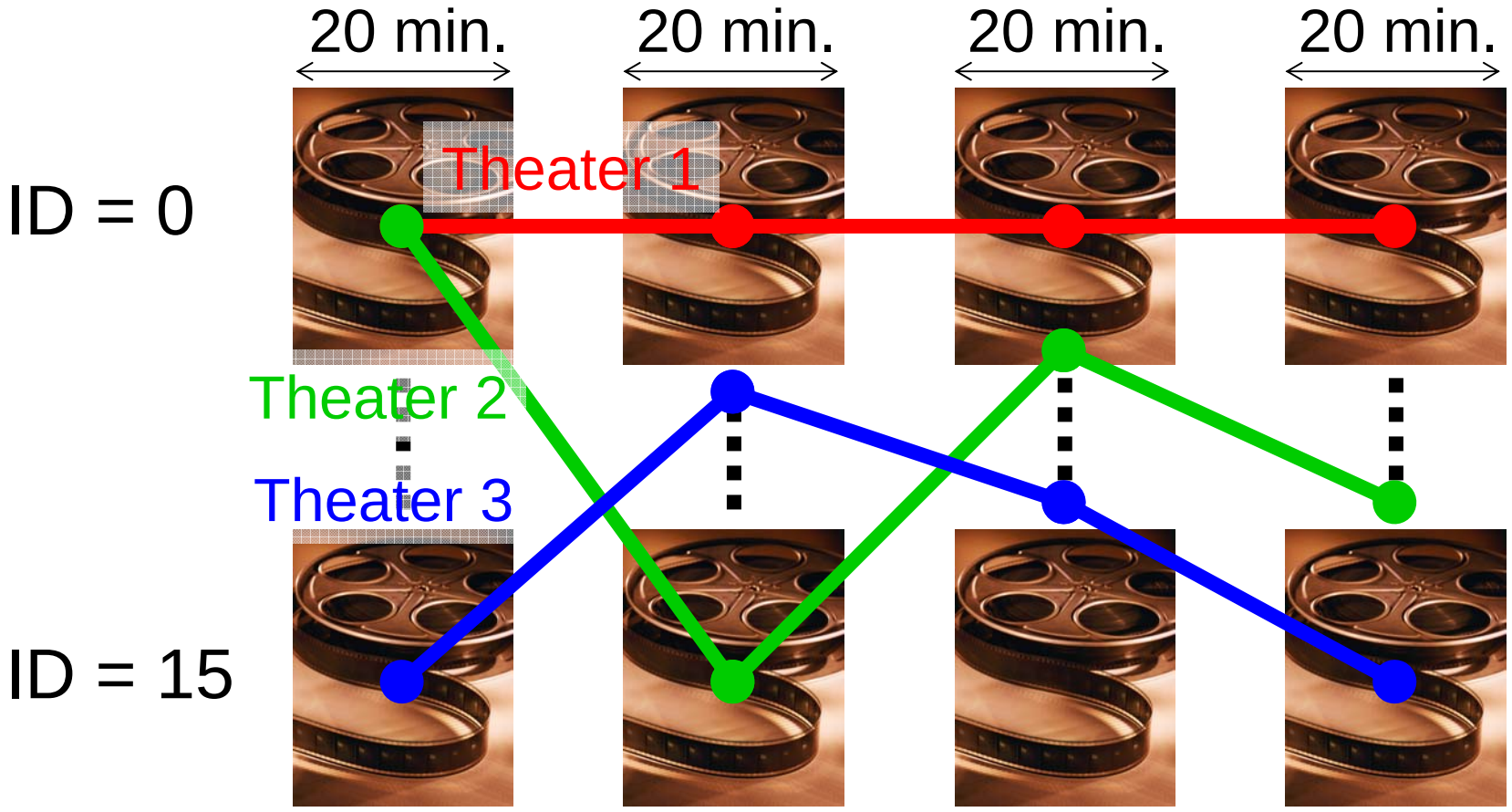
- **Mark the content on-the-fly**
  - Marking of the content can be performed by PC



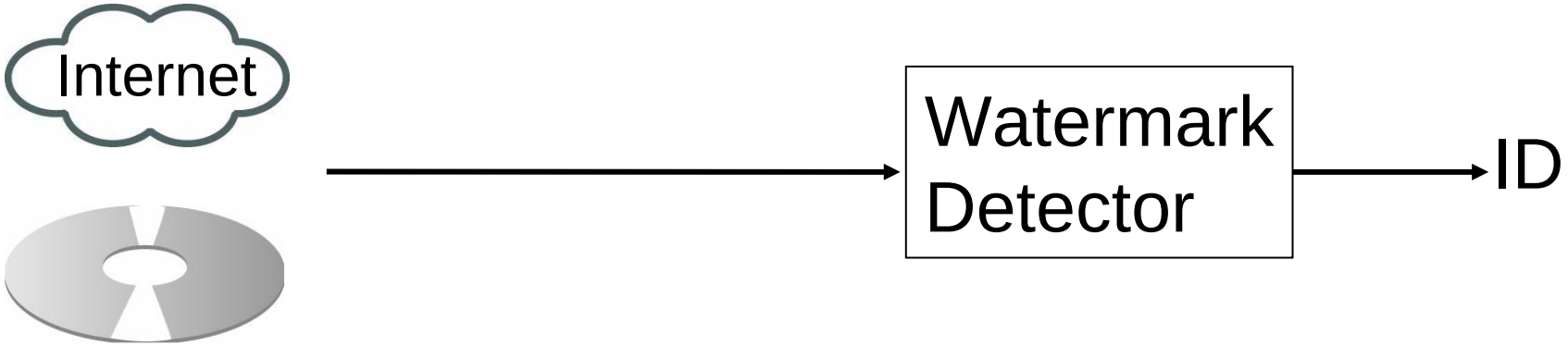
Theater ID
(Constant value throughout the movie,
or varying in a certain time)

System Model for Marking (Film Theater)

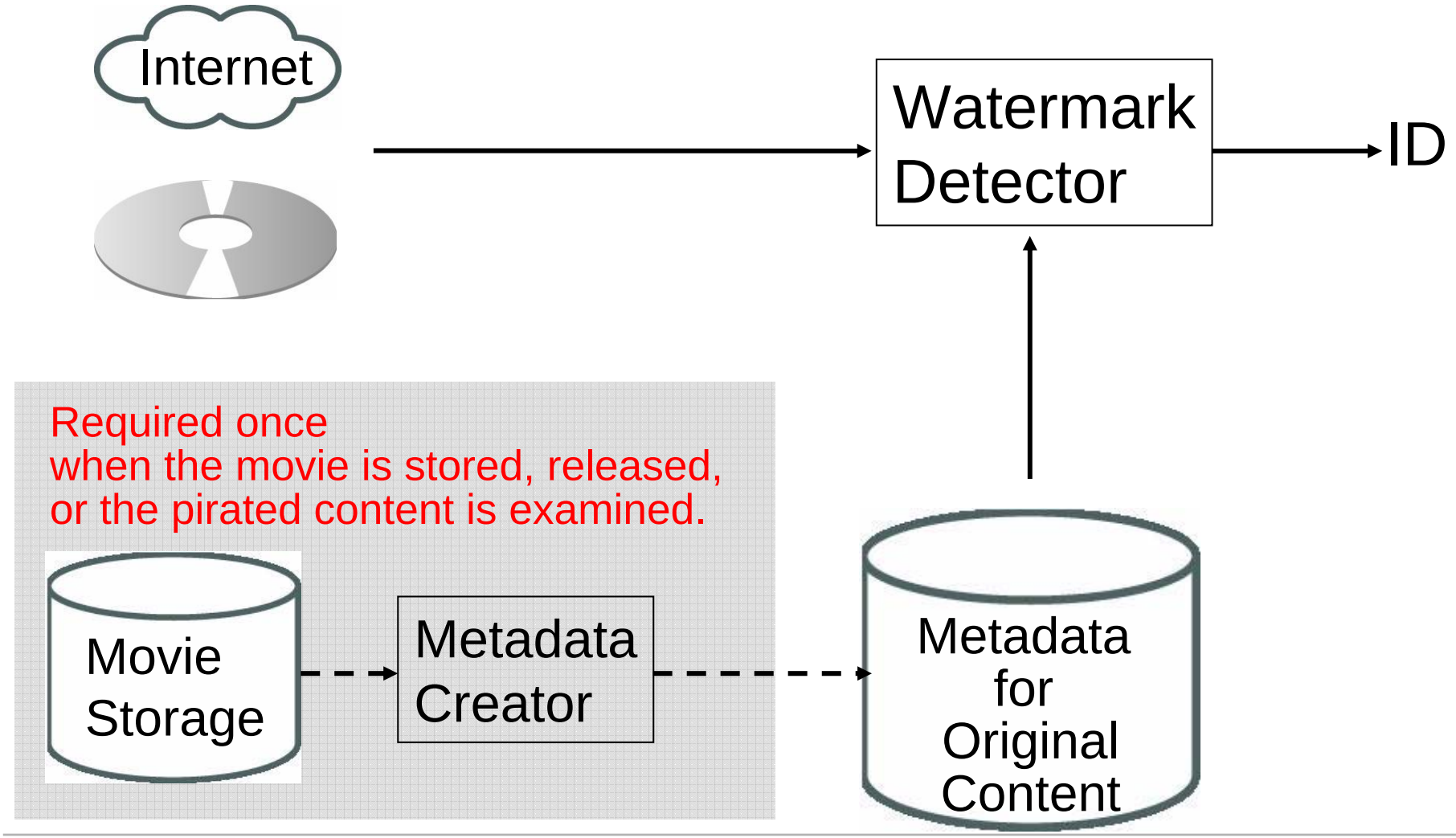
- **Only 16 kinds of master film are required for each reel to identify 65536 screens.**



System Model for CCI Detection



System Model for Forensic Mark Detection



Computational Burden

- **Embedder**
  - Realtime embedding on 4K2K 30p baseband signal (except file I/O) by Core2Duo (dual core) @2.66GHz

- **Detector**
  - Realtime detection for 4K2K 30p baseband signal (except file I/O) by Core2Duo (single core) @2.66GHz

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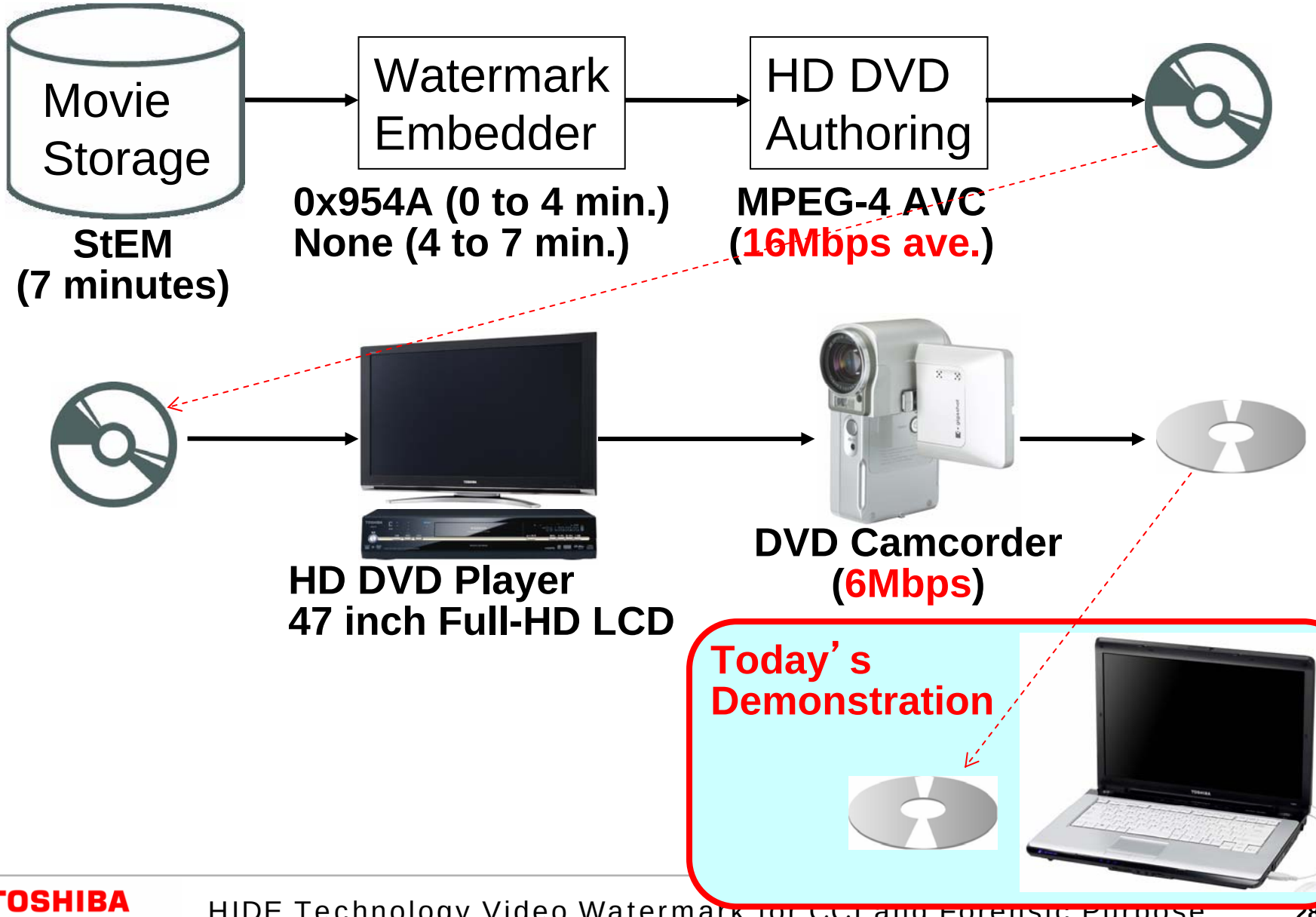
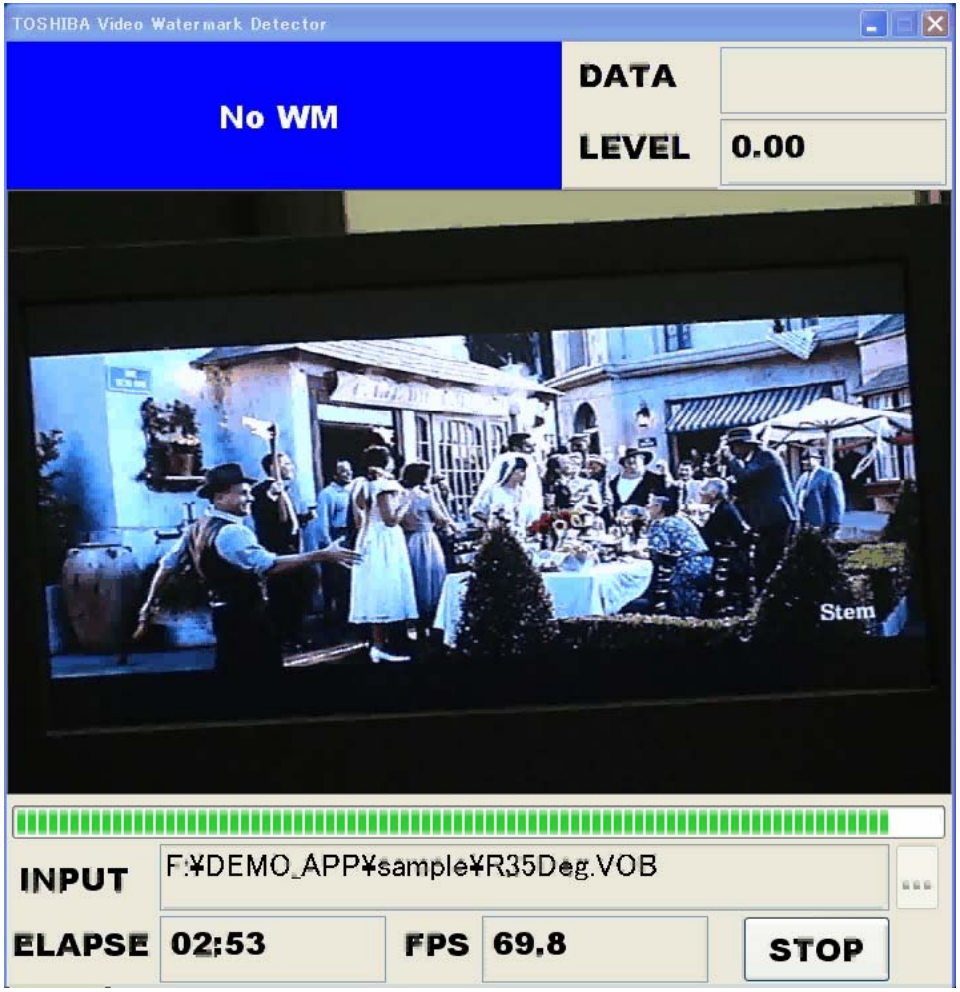
Demonstration

Demonstration System



Demonstration



Conclusion

- **HIDE Technology watermark survives in camcorder piracy video**
  - Applicable to forensic marking in addition to the carriage of CCI

- **Toshiba is ready to provide evaluation software (embedder and detector) under contract**
  - Toshiba has already integrated embedder to Toshiba MPEG-4 AVC encoder for HD DVD authoring

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