



l e a d i n g t h e w a y



The Pros and Cons of JPEG 2000 for Video Archiving

JPEG 2000

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November, 2010

Overview

- **Introduction**
 - Current situation
 - Multiple challenges
- Archiving challenges for cinema and video content
- JPEG 2000 for Video Archiving
- intoPIX Solutions
- Conclusions

JPEG 2000

Current Situation

- Most museums, film archiving and broadcast organizations
 - digitizing available content considered or initiated
- Both movie content (reels) and analog video content (tapes)
 - Digitization process and constraints are very different.
 - More than 10.000.000 Hours Film (*analog = film*)
 - 30 to 40 % will disappear in the next 10 years (*Vinager syndrom*)
 - *Digitization process is complex*
 - More than 6.000.000H ? Video (*90% analog = tape*)
 - *x% will disappear because of the magnetic tape (binder)*
 - *Natural digitization process taking place due to the technology evolution.*
 - *Technical constraints are easier.*

Multiple challenges

- The goal of the digitization process :
 - Ensure the long term preservation of the content
 - Ensure the sharing and commercialization of the content.
- Based on these different viewpoints and needs
 - Different technical challenges and choices
 - Different workflows utilized
 - Different commercial constraints
 - Different cultural and legal issues

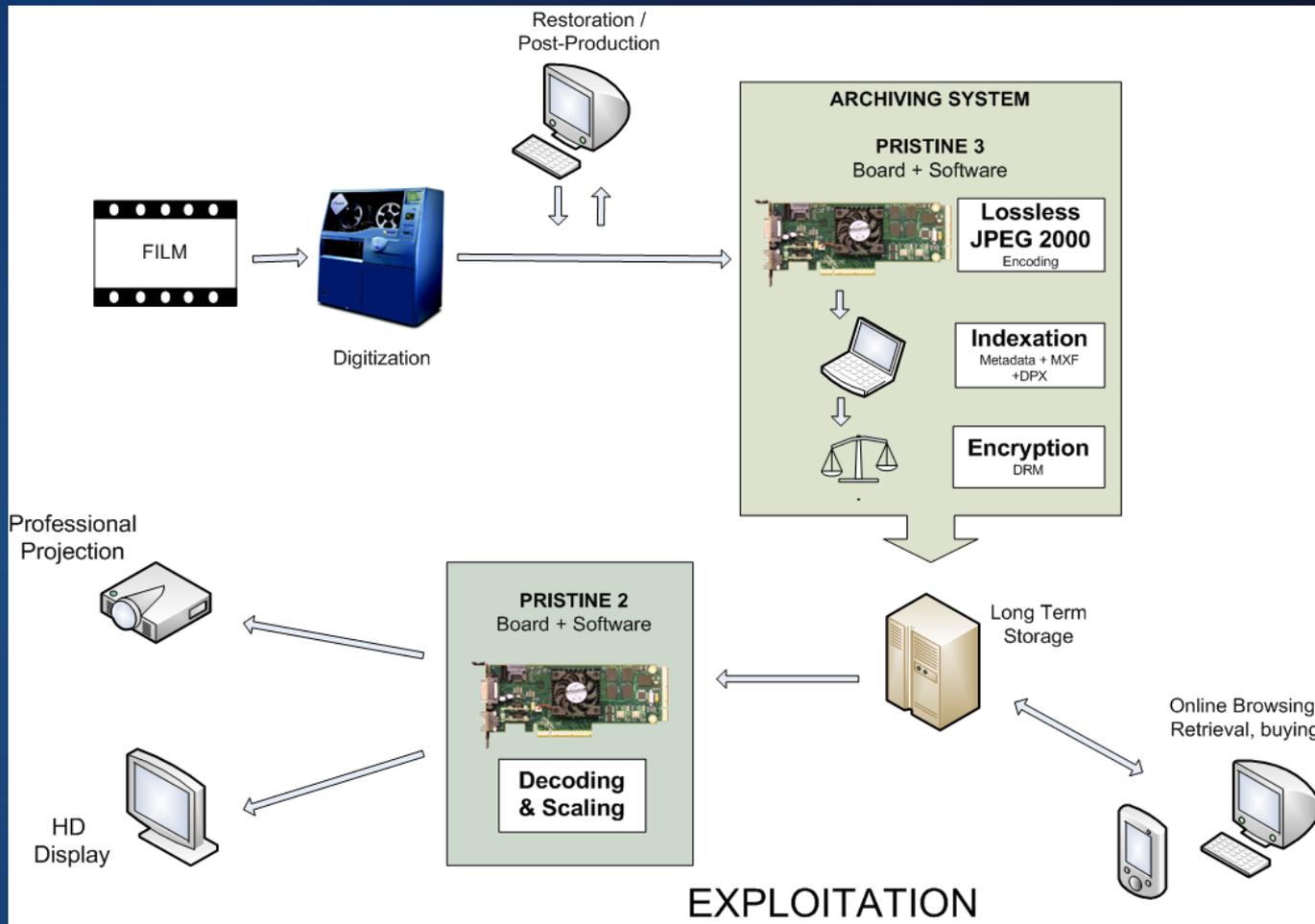
Overview

- Introduction
- **Archiving challenges for cinema and video content**
 - General archiving concerns
 - Benefits of J2K
 - intoPIX experience
- JPEG 2000 for Video Archiving
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General archiving concerns

- Goals
 - Preservation
 - Long-term : interoperability, wide format adoption,...
 - Lossless : maintain source quality
 - Valorization
 - Need for distribution via different media
 - Potential On-line access
 - Interoperability with browser
 - Low resolution proxy from source data
 - Security and business model
- Workflows
 - Digitization (scanners, ...)
 - Restoration (or post production)
 - Storage & Metadata Indexation
 - Valorization / Exploitation



Archiving concerns for Film

- Film archives: Cultural heritage preservation
 - Transparency 4K+(?) digitization
 - **Strong technical constraint**
- Output format : 24 Fps (4096*3112)
 - Digital resolution 2K(2048*1080) - 4K (4096*2160) DCI
 - Data File format DPX Digital Moving-Picture Exchange SMPTE 268M-1994
- Now DPX + MXF + Metadata
- Compression > Lossy Compressed or not ? > JPEG2000 DCI
- Huge file (TB) & Processing Time

Archiving concerns for Broadcast

- TV archives SDTV and HDTV usage
 - No particular technical constraint
- SDTV – 625/50/i (720*576*50i)
 - Recording format: DVCpro 25-50 (DCT if), D5 no compression
 - Digital Beta, IMX (MPEG-2 4:2:2P@ML 50Mbps if) , SX
 - Both DVCP & IMX in Tape & File
 - AAF Advanced Authoring Format > MXF (wrapping!)
- HDTV 1080i/50 1920(H) x 1080(V) & 720P/50 1280(H)x720(V)
 - Compressed DVCPROHD100, HD D5 235 Mb/s,
 - HDCAM 1080i (Video 143 Mb/s propri), HDCAM SR 440 Mb/s
 - AAF Advanced Authoring Format > MXF

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- **JPEG 2000 for Video Archiving**
 - JPEG 2000 for archiving
 - JPEG 2000 for cinema archives
 - JPEG 2000 for broadcast archives
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JPEG 2000 for archiving (1/2)

- Adoption

- International standard (ISO 15444-1): interoperability between storing and access systems.
- Official video format of the Digital Cinema Industry (DCI : Digital Cinema Initiative)
- Adopted by numerous digital libraries, see e.g. :
 - Library of Congress,USA
 - Recent Canadian study listing all archiving initiatives based on JPEG 2000.

- Features

- Preservation of the source quality
 - True mathematically lossless
 - Lossless coding: Reducing the storage space by a factor of 2 to 3.
 - « Visually lossless » compression: Quality by far superior to JPEG
 - Support of Metadata

JPEG 2000 for archiving (2/2)

- Features (ctd)
 - Content Access
 - Multi-resolution flexibility: proxy version embedded in lossless file
 - Modular file structure
 - Enabling fast and efficient browsing JPEG 2000 data bases.
- Other aspects
 - Security: Encryption and Digital rights management
 - Protocol for on-line browsing JPEG 2000 images
- JPEG 2000 add-ons
 - Support of encryption and digital rights management (DRM) rules (J2K part 8 "JPSEC")
 - Protocol for online Interactive browsing of J2K content (J2K part 9 "JPIP")
- Cost
 - License Free, royalty free

JPEG 2000 for Cinema archiving

- **Adoption**
 - Is the only permitted standard for Digital Cinema.
 - Adopted by the DCI : a joint venture of Disney, Fox, MGM, Paramount, Sony Picture Entertainment, Universal and Warner Bros.
 - Digital Cinema Initiative : www.dcinovies.com/
- **Technical merits :**
 - Digital Cinema archive, editing and distribution
 - Resolution, color gamut and dynamic range exceed DC requirements
 - Digital encoding and preservation of film
 - Where re-tasking of the image data needs to be easily achieved
- **JPEG 2000 : the following parameters in Digital Cinema are possible, but not limited to:**
 - Resolutions of 8192x8192 Pixels : e.g. 4096x3112 for 35mm Film Scans
 - Colour space : sRGB, SRGB-YCC
 - Number of colour channels: 3-4 (e.g. RGBA)
 - Bitdepth: 10-16 Bit/colour component
- **Can be synchronized with sound**
- **Compression types:**
 - Mathematically lossless
 - Visually lossless
 - Lossy

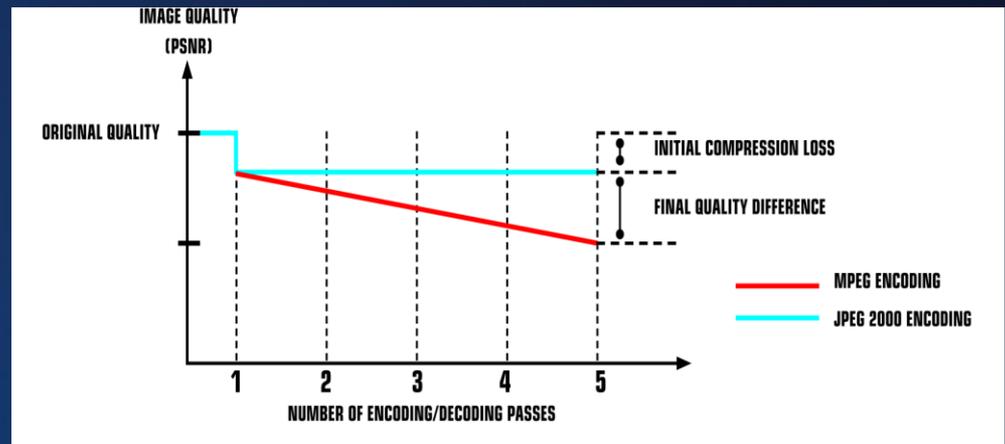
JPEG 2000 for Broadcast archiving (1/3)

- Adoption

- Adopted by the Library of Congress, LAC, CPB (US Community for Public Broadcasting – JPEG 2000 + MXF or MOV - anticipated) and other such organizations
- Broadcast profile : Many parameters are similar to those of the DCI profile, allowing sw and hw re-use
- Is started to be the widely adopted standard codec for Broadcast contribution
 - Need for a versatile mezzanine format

- Technical merits :

- No additional loss of data even after repeated encoding/decoding cycles
- Very easy synchronization for 3D applications
- Low latency
- Broadcast Profile to be published



JPEG 2000 for Broadcast archiving (2/3)

- JPEG 2000 – MPEG comparison :

- Frame by frame compression

- All images have same quality
- Low latency
- No error propogation

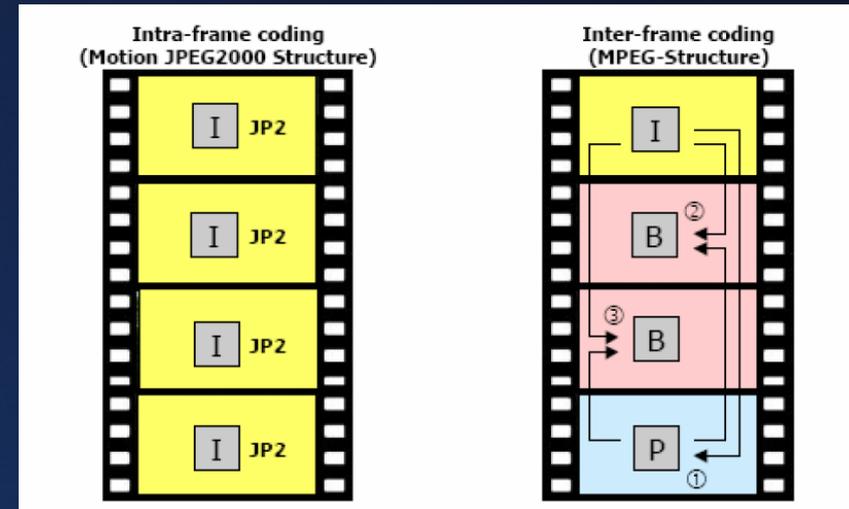
- Wavelet transform

- All pixels subject to same processing (no macro blocks)
- High efficiency

- Compression range : Visually lossless to true lossless

- Dynamic range : 10 bits to video range

- Error concealment : easy



JPEG 2000 for Broadcast archiving (3/3)

- JPEG 2000 – Broadcast profile :
 - Use of the CPRL progression order :
 - Based on system scalability and cost
 - Stable transmission environment, dedicated communication lines
 - Permits easy rearrangement
 - Component separation to multiple codec designs
 - Reduced memory
 - Defines an elementary transport stream
 - Defines a profile suitable to the broadcast environment and applications
- Co-existence of multiple codecs
 - Depending on the particular requirements for exploiting the content on different platforms, different codecs continue to co-exist
 - JPEG 2000 used as contribution and mezzanine format
 - Dedicated transcoding solutions to H.264 in varying bitrates allow for access in reduced bandwidth situations
 - Need for single master format, not various files depending on ultimate exploitation

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 - Pristine Board
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PRISTINE Video Board



PRISTINE Key benefits for Archiving

- **Compression :**
 - Formats : Mathematically Lossless, Nearly Math. Lossless and Visually Lossless.
 - Very high frame rates: up to 120 frames per second for HD (2K) resolution.
 - Variable resolutions supported: 1920x1080 (HD), 2048x1080 (2K), 2048x1556 (2K+), 4096x2160 (4K), ...
 - Scalability: several resolutions or quality versions embedded within a single code stream
- **Additional features :**
 - Easily reprogrammable : can be configured as recorder or player.
 - Uncompressed Audio
 - Time codes for Audio & Video synchronization
 - OS: Windows, Linux, MacOS X
 - Multiple boards support in one system
 - Rescaling: from 2K (HD) to 4K (QuadHD) and reversely

Valuable Options

- Support of meta-data **file formats**: MXF, DPX.
- **On-the-fly Quality control**
 - using 2 PRISTINE boards enables you to control the quality of the compression in real-time.
- **3G-SDI Panel**
 - 4 inputs and 4 outputs also supporting HD-SDI, Dual-SDI and SDI.

PRISTINE specifications

- PCI-Express x 8 (up to 2 Gbytes/s in and up to 2 Gbytes/s out)
 - Encoder in : 4K @ 24 fps 4:4:4 12 bits ~1 Gbytes/s
 - Out : compressed JPEG2000 file (up to mathematically lossless)
 - Decoder in : compressed JPEG2000 file (up to mathematically lossless)
 - Out : 4K @ 24 fps 4:4:4 12 bits + 1 Gbytes/s
- HDSDI-out : up to 4 x 3G
 - Support of 4K @ 24 fps 4:4:4 12 bits
- HDSDI-in : up to 4 x 3G
 - Support of 4K @ 24 fps 4:4:4 12 bits

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Conclusions

- JPEG 2000 compression ideally suited for the archiving market
 - For preservation : up to mathematically lossless coding
 - For exploitation : as mezzanine format for different applications
- JPEG 2000 and other codecs are complementary :
 - Standard codec in designated markets
 - Reference codec for broadcast archives
- JPEG 2000 is a cost-effective solution :
 - System scalability prevents multiple equipment needs
 - Digitization limits needs for storage capacity within an environment with massively exploding content delivery
- Additional software modules :
 - MXF and JP2 wrappers developed for film/broadcast/document archiving
 - Tiling modules for large images

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Thank You

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