

Master “Thing” Discussion Items for SMPTE DC28.2

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Master “Thing” Data Format

Make New Standard
Make Independent of Source Details
Make Independent of Destination Details
Make Time Independent
Make Scalable
Consider Technology Developments
Make Future Proof

A NEW Standard

Design Life Expectancy 50 Years
Design to SI units if Possible
Make no technology assumptions
Create COLOR SPACE for best translation from sources and to destinations products.
Define translation from old “standards”

What is THE Digital “Thing”

- DIGITAL CINEMA MASTER DATABASE(DCMD)
 - Contains:
 - Video, Audio, Effects, Metadata, Sprites– etc.
 - Derived from Digital Cinema Input Databases (DCIB)
 - Many inputs converted to common format
 - Output to Digital Cinema Distribution Database (DCDD)
 - Multiple DCDD’s per Studio needs.
 - DCDD’s gets converted by display mechanism
- All Storage in lossless compression modes

DIGITAL MASTER DATABASE IS:

Images converted to SI unit in DMD and corrected for source effects
Time Stamp (Second/Partial Second) of each object
Sound objects corrected for source effects
Metadata included
All audio/video/effects objects with timestamp
IP Tracking information on all above. TBD
Always converted TO and FROM
This is a **DATABASE!!**
Wide COLOR SPACE

DCMD COLOR SPACE OPTIONS

- SI based spectral array per pixel

RGB refinement is a subset of the full color space
Allow for Sensor Development
Allow for Less Expensive Storage
MAKE Long term commitment

- CIE Diagram Based system as SECOND CHOICE

Convert to CIE Diagram

x = 16 bit value from 0 - 1

y = 16 bit value from 0 - 1

Intensity Value (z) 16 bit value range 0 - 100%?

Each Pixel completely described.

OR Color Vectors X,Y,Z with values in 48 to 64 bit integer

DCMD RGB Color Space Option

Uses current RGB technology extended to 16 Bit numbers. This is a subset of the SI based spectral system with the Red, Blue and Green elements described in the pixel definitions with appropriate wavelengths for the capture element.
All work is equivalent of 4:4:4 with each pixel completely described.

DCMD SI Color Space

Should be SI based

Variables are Spectrum, Luminosity and Polarization

Each Pixel has a spectral content with energy at many wavelengths

Define an array of lambda vs intensity that can be expanded as technology permits.

Lambda in 0.1A (10^{-2} nanometers) 30000-94000? IR to UV.

Intensity per lambda range in Lux?

Each image contains spectral definition matrix

Spectral Data allows later modification of

RGB is a 3 Element matrix with each element specified by wave length - Which green?

Color Space Independent of Source

All Sources Have Different Color Spaces

DCMD Brings All Sources to Common Space

Non Linearity's of Pick-ups Removed

Non Linearity's of Lenses Removed

CGI colors captured in SI terms

Older Material Scanned to Common Standard

Common Color Space based on spectral density

All possible defects from source removed

All gamma corrections removed.

Space Independent of Destination

- Display/Projection Mechanism UNKNOWN
- Display corrections/linearization must be done at display/projection device:
 - Gamma corrections for projection mechanism
 - Gamma corrections for local lighting conditions
- Sound must be corrected for acoustic conditions of display environment:

- Delays and EQ corrected for room timing as now
- Match to equivalent of Screening Room

Incorporate Simplified Time Code

- Time tag is either:
 - Display time – relative to start
 - Capture time – NPT time – GMT with offset for 1900 or 2000
- Use 64 bit time code
 - 32 Bit seconds,
 - 32 Bit partial Second (232ps Resolution)
- Frame time variable to meet needs.

Color Space with Growth Ability

Proposed storage method allows expansion to extended spectral content.
More elements to work with for effects.
Sensor technology will improve with time and can be used.
Current RGB and CIE is subset of SI space
All manipulations are digital computation

Scalability Must be Built into Color Space and file format

Improved technology will continue to present better resolution and better color response with additional spectral lines and resolution.

- Dimensions of the image
 - Frame Pixels dimensions from 2K to 64K in both row and columns
 - Spectral Content will increase as silicon speeds improve, current limit of 3 is based on current cameras. High spectral can now be achieved at slower rates – which will improve in time.
 - Time of capture/display will speed up quickly.
 - More than one image per frame time stamp for stereo and beyond.

Technology Landscape/Timeline

Processor power doubles each year
Storage costs decrease by 2 each year
Communications widths increase by 2 each year.
Planning for 15 to 25 year life is improving compute, storage costs, and communications by 3 to 4 orders of magnitude.

Current Storage Costs January 2000

Costs of data storage is dropping each year. Technology continues to decrease costs on an average of 50% per year. Examples
4mm/DLT Tape = \$2/Gigabyte
8mm Tape = \$1.25/Gigabyte
Disk = \$7.5/Gigabyte
50Gbyte movie - \$62.50 to \$100.0 in Tape
50Gbyte movie = \$375.00 in disk

Production Storage Costs

Frame = 1920x1080x6 = 12.4416Mbytes/Frame

Starwars Episode 1 reported 204 Hrs of film with $204 \times 3600 \times 24 = 17.6256$
Million frames to make 219.29066496 Terabyte raw material which would cost
\$127,643.50 for tape storage at 2x compression and this cost is decreasing by
50% per year
This film is estimated at 1.106 million feet of film $\$0.40/\text{ft} = \$442,400.00$
Other films us a lot less material.

Future Proof Planned Life

Minimum Planning time = 25+years.
Physics will not change
Sensors will improve rapidly
Display technology will improve rapidly
Creativity continues unabated
Technology will change rapidly
Inevitable

Standards should be defined for:

Project File Descriptor
Scene/Take/Element file Descriptor
Frame Descriptor
DMD frame at standard sizes

Element of a DCMD are:

Descriptor Files

Project File/Descriptor
Working Name
Project number
Charge number
Key personnel and titles
Ownership definitions
Other Studio information (TBD by studio participants)

Scene / Take Descriptor

Time and place
Production Crew
Talent
Support personnel
Other Staff
Resources
Contractors
Properties used
Equipment used

Make, model, serial number

Source

Calibration

Element Descriptor

Frame Descriptor

Number of columns (line elements)
16 bit line element space

- 16 bit row space
- Time Code (64 bit) – capture or presentation
- Frame type
 - Computer Graphics Image
 - Film scanned image
 - Direct Camera image
 - Color Calibration image
 - Lens calibration image color fringing
 - Zoom Calibration Image
 - Sprite Layer
 - Composite element type
 - CCD Pixel linearization map/image

Pixel Descriptor

- Number of Spectral Lines (example 3)
- List of spectral lines (example red(), blue(), green())
- Polarization of light
- Pixel vertical subtended angle in micro radians
- Pixel horizontal subtended angle in micro radians
- Priority of pixel

Frame Data Structure

Line 0 (first line)

- Time Code (NPT) 64 Bit
- Project Descriptor file name 32 bytes
- Scene / Take Descriptor file name 32 bytes
- Element Descriptor file name 32 bytes
- Frame Data Descriptor file name 32 bytes
- Pixel Descriptor file name 32 bytes
- Frame Layer in structure – 2 bytes
- Copyright Notices
- Other Property Ownership Notices
- Notes = Line length – above bytes (~ 12Kbytes – above)
- Line one CRC 8 bytes

Pixel Data

- 2048 x 2048
- 4096 x 4096
- 8192 x 8192 ...
- to 65536 x 65536

CRC on Line

CRC on Frame

Forward Error Correction for element

Theatre Systems

Receive Flat image from distribution

Apply Geometry Map

This allows the removal of Keystoneing and other geometrical aspects of the display venue to be corrected for and the pixels remapped to present in the prescribed format.

Digital Cinema Mastering Issues.

Apply Lens correction mapping

Non linearity

No lens is perfect and can be somewhat compensated for.

Color defects in projection lens (edge effects)

Remap pixels to land on proper area of screen (or other media)

despite lens or other distortions for color or other.

Add Watermark for presentation

This would include time stamp, date stamp (NPT) and venue ID. The

purpose is to provide complete tracing to loss mechanism

Flatten luminosity from measured device map

Map color space to display color space

Projector type

Display medium –

Plasma

LED

Laser

Incandescent bulbs

Other

Add Gamma correction based on device

Add Gamma correction based on illumination

Correct pixel data from response map

Map Audio from reference model to real theater

Provide sound to seat?

Property Security

Do theatre mapping before sending to theater

This severely limits play back on unintended systems