Digital Cinema Specification

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Agenda

- Short E-Cinema discussion
- Historical (?) view of the Path to Digital Cinema
  - Why does the spec make sense?
- The DCI Spec - Executive Summary
  - DCDM • Packaging • Encryption and Key Management
- Q&A

Cinema's Digital Future

- E-Cinema
  - In-Theater Advertisements
  - ODS (Other Digital Stuff)
- D-Cinema
  - Digital Cinema for major releases

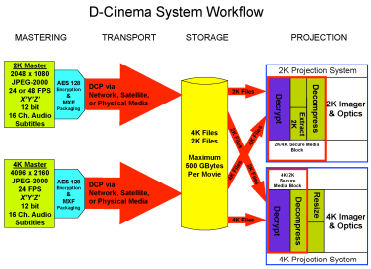
E-Cinema

(In-Theater Ads - Not D-Cinema)

- Replace 35mm slide projector with low cost projector and server
- Run Ads / infomercials before lights down AND ODS (Other Digital Stuff - Rock concerts, Sports, etc.)
- Also includes lobby video screens

DCI Specification

- Picture
  - 12bit X'Y'Z' color
  - 2048x1080 24p/48p or
  - 4096x2160 24p
  - JPEG2000 compression
- Sound
  - 16 channels max; 24bits deep; 48/96Ks/sec
  - NO COMPRESSION
- Subtitles
  - Text rendering in system or
  - PNG Alpha channel
- Flow and Reels
  - Elements delivered as package or separately
  - Broken into "reels"
  - Playlists reconstruct playout in theater
- Packaging (MXF)
  - Delivery of encrypted elements using MXF
- Security / Encryption
  - Elements encrypted and keys delivered for playout



History

1999

Disney / Texas Instruments / Technicolor Experiment (about 40 screens)

What We Learned

- Consumers LIKE Digital Cinema
- TI projectors WORK
- We need a standard… who better than **SMPTE!!**
- It costs a lot! Hard to make content without DI
- We had a lot to learn
  - How to make digital content
  - How to distribute
  - How to have a common format

History

1999

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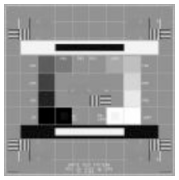
2000

SMPTE to define needs and write Technical Standards

DC28 was formed



It's SMPTE Time

- Eight groups
  - Steering, Mastering, Audio, Compression, Encryption, Packaging, Transport, Theater Systems
- Study Reports published … wildly successful.. Summer 2001 published
- It brought good, smart engineers together to identify the issues and start the standardization process
- Let the acronyms begin

DCDM numbers game

- V6.0 4928x2048
- V5.5 3680x1536
- V2.5 2464x1024
- Others: 1920x1080; 3840x2160; 4096x2048

(Today it's 4096x2160 or 2048x1080)

History

1999
Disney / Texas Instruments / Technicolor Experiment (about 40 screens)

2000
SMPTE to define needs and write Technical Standards

2002
DCI
DCI with all the studios to write specification

During the DCI Age

- Decisions were made
- Testing and finally got the 2K/4K Layered compression and JPEG2000
- Finalized the audio - including 96K
- The spec publishing adventure
- StEM
- Some early companies withdraw, new companies enter

DCI Adventure

- Image resolution and Color
- Audio bit depth and sample rates
- Compression type and bit rate
- Subtitle types and limitations
- Encryption and Key exchange methods
- Packaging and metadata

StEM

- StEM (Standardized Evaluation Material) - a 12 minute movie without entangling licensing conditions
- Designed to be best film can offer and all sorts of challenging scenes
- Was funded by DCI and had many fathers/contributors - ASC, DCI, Studios, suppliers
- You will see this a lot at NAB and for the next few decades (really!)

History

1999
Disney / Texas Instruments / Technicolor Experiment (about 40 screens)

2000
SMPTE to define needs and write Technical Standards

2002
"The Ice Age"
DCI with all the studios to write specification

2005 Today
Predicting the future is easier after the fact - listen tomorrow!

Writing Future History

- Real money, real systems, real deployment
- Use of the DCI spec
- SMPTE finalizes the standards
- Continued discussions with all involved parties to meet market needs

DCI

Digital Cinema Initiatives

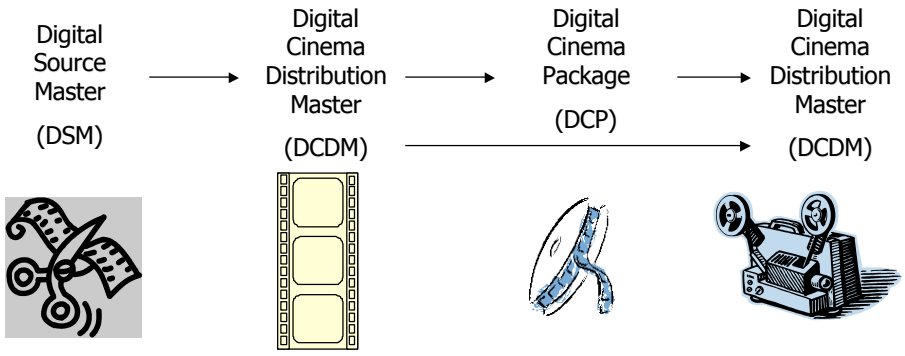
Disney, Fox, MGM, Paramount, Universal, Sony, Warner Bros

A ***voluntary*** specification

Goals of Digital Cinema

- Image better than answer prints
- Presentation better than the home
- Extensibility for better presentation
- Maintain backward compatibility
- Worldwide system
- Reduced distribution costs
- Long term viability
- New pallets for telling stories

Simple Functional Flow
TLA's and FLA's



OCN → IP → IN → Release print

Original Camera Negative | Interpositive | Internegative

Digital Cinema Workflow

Master and approve the digital presentation
(normally part of DI process)

↘

Prepare sound / image / subtitles / flow.

↘

Encrypt, Compress and Package it
using TLA* techniques.

↘

Ship it Satellite or hard drives

↘

Load it in the theater,
test it, program it

↘

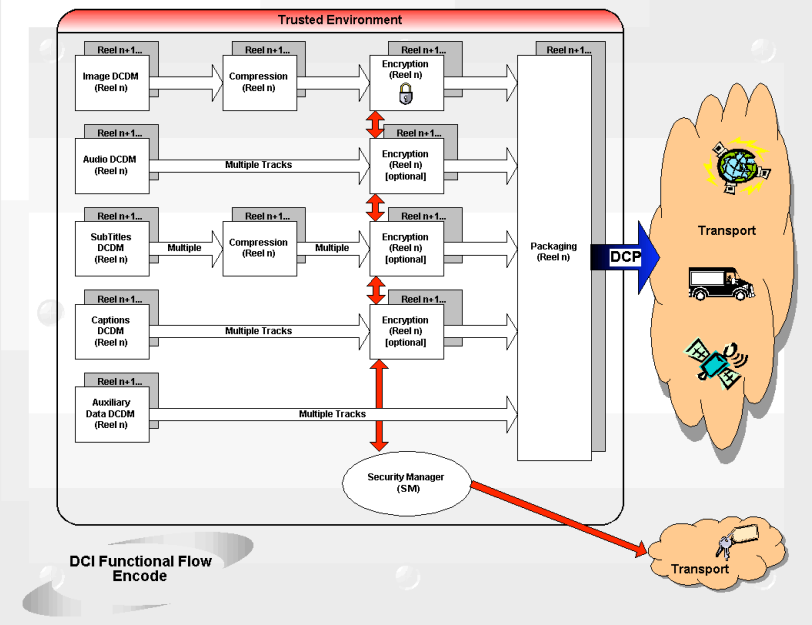
Play it on the screen.
Make money

Keys → Load it in the theater, test it, program it

Keys → Play it on the screen. Make money

Reports ← Play it on the screen. Make money

* TLA - Three Letter Acronyms



Encoding Functional Flow

Picture: Better Than an Answer Print

- Every theater can have “premiere quality” experience
- Maintains the theatrical experience above the home experience
- Long lasting, non-proprietary
- In the spirit of 35/70mm:
  - All formats supported 2.40, 1.85, 1.33 +
- The first systems will play future movies
  - Early adopters will benefit from improvements from the start

DCI Spec

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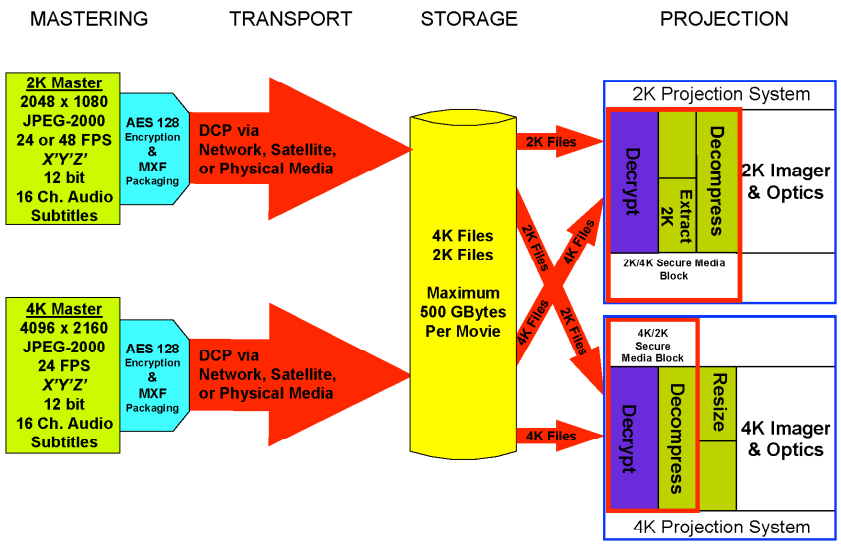
D-Cinema System Workflow



Picture

- Resolution, Color, Compression
  - 2048x1080 OR 4096x2160 FLAT
    - Only active pixels are transported
  - 24/48 frames per sec
  - X'Y'Z' 12 bits / color
  - Hierarchical (Layered) Image Structure

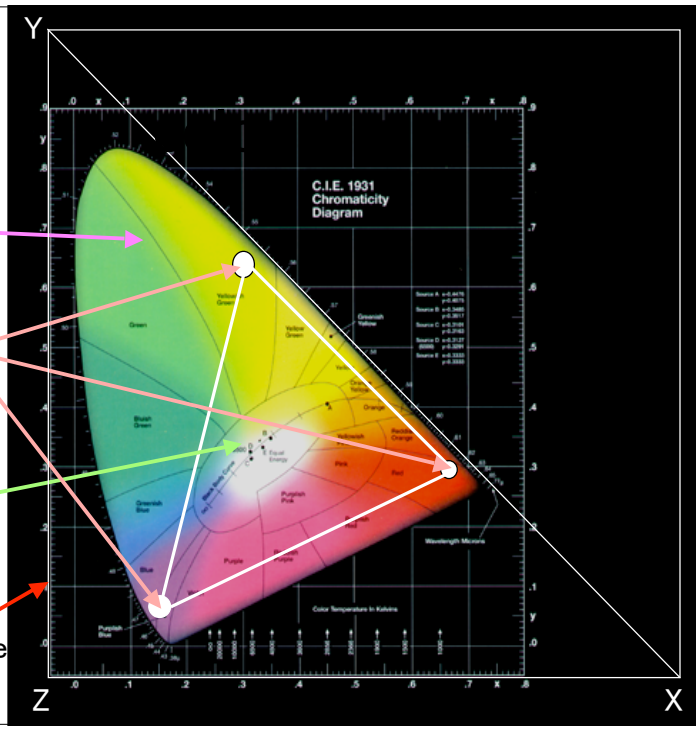
Visible and XYZ

Visible colors

Current Display Primaries

White Point

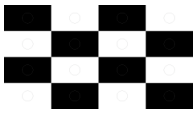
XYZ encoding Space (triangle

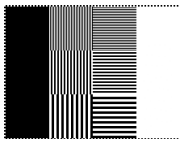


Requirements Testing

Objective Testing
- Screen Luminance
- Contrast
- Dynamic Range (Transfer Function)
- Geometry
- Compression (Picture Signal to Noise Ratio)

Subjective Testing
- Visual Discrimination Threshold (Bit Depth)
- 35mm Answer Print side by side with Digital Cinema
- 24 to 48 Frame play out comparison (Proof of Concept)
- Compression



JPEG2000

- No temporal compression
- One tile
- Extracted 2K from 4K
- Max 250Mb/sec - all formats
- ICT required
- 9/7 inverse wavelet transfer function
- Guess: typical 2K 24fps movie: about 150Gbytes

Sound: Best Studio Quality

- The same delivered sound as was mixed on the sound stage
  - 16 channels Uncompressed sound 48/96K, 24bits
  - Able to support multiple languages, commentary, audio headphone tracks

Sound Extension

- What would you do with 16 channels?
  - Future proof - some research into 10 channels in theater
  - Defined 5.1, 6.1, 8.1 plus hard-of-hearing, plus alt languages configurations
  - You don't need to send all channels
  - You can send multiple sets of 16 (alt languages)
- 96K sample rate?
  - Future proof - home allows delivery of 96K sample

Subtitles

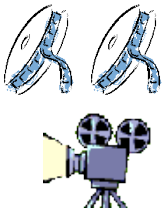
- Defining subtitles not a simple task
  - 500 meetings dedicated to definition
- On Screen
  - Part of “movie” - Localization, translation
  - For hard-of-hearing
  - For foreign translation
- Off Screen
  - Hard-of-hearing, alt language

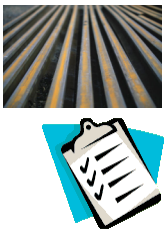
Supported Subtitles

- Text - rendering in the projector or server/media block or alternative display
  - Selectable fonts and installed fonts
- PNG 32bit color alpha overlay
  - Bit rate limit 20Mb/sec
  - Bounded rectangles at image resolution
    - 2K or 4K

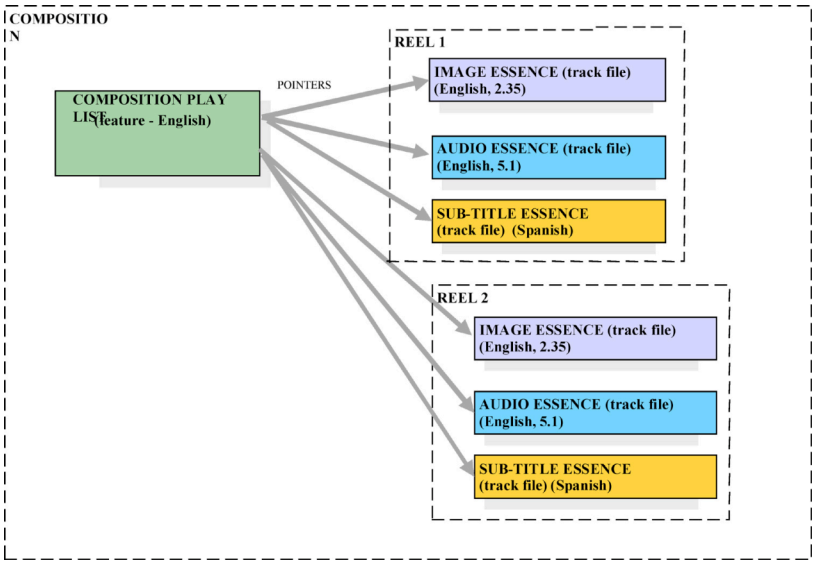
Packaging Format

- Based upon “Reels”
- Reels can be electronically spliced together to create a “Composition” (Feature, Trailer, Logo etc.)
- Reels include parallel Track Files of different Image, Sound, Subtitles etc.
- Track Files are tied together by Composition Playlists

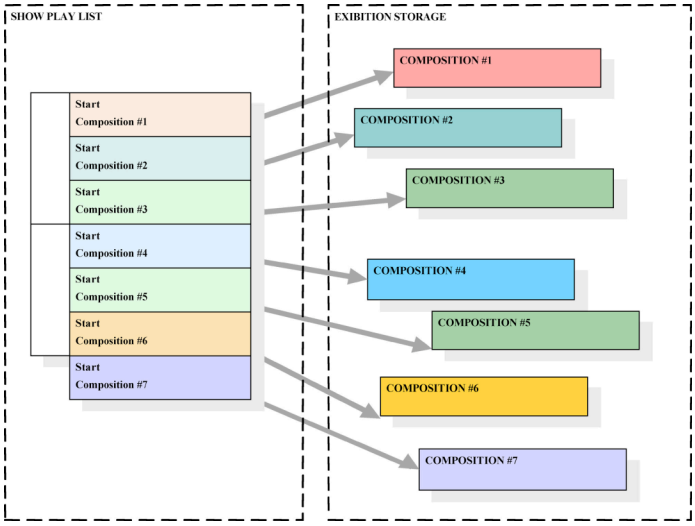




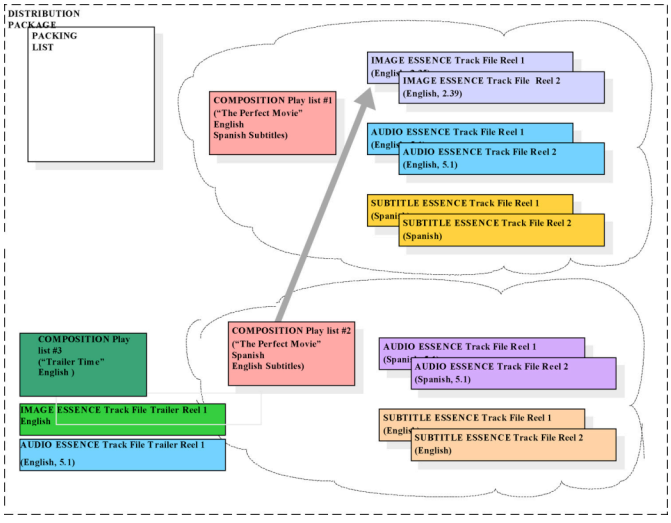
Composition Play List



Show Play List



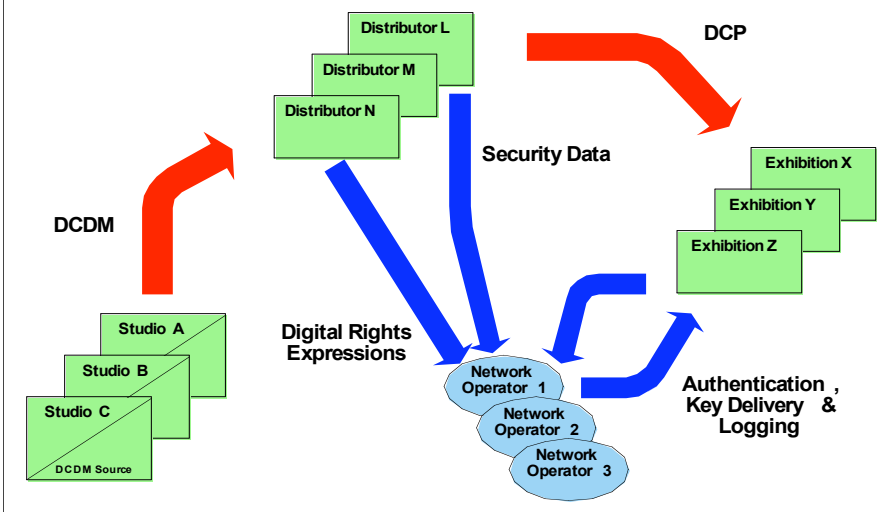
Distribution Package

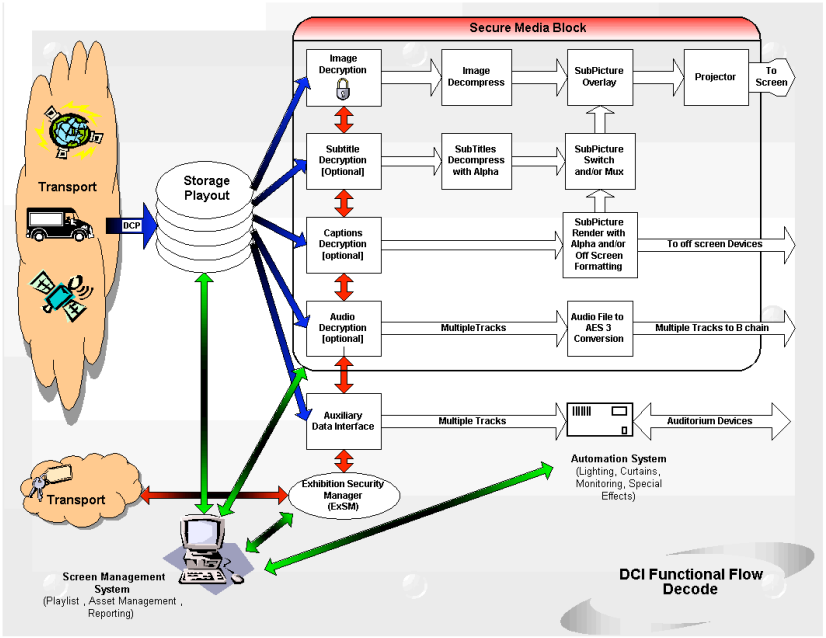


Secure

- Problem: Pirated Movies
  - Camcorder & Digital Theft
- Solution: Security
  - Camcorder
    - Forensics/Fingerprinting marking
  - Digital Theft
    - Encryption & Key Management

Security Management Reference Model

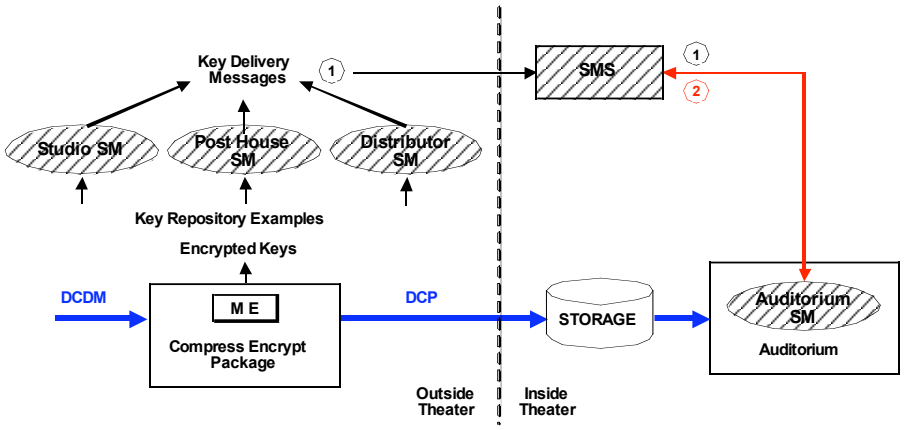




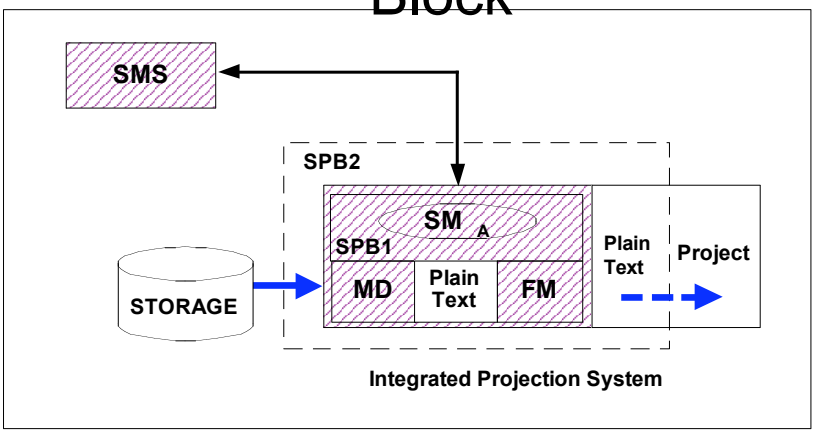
Digital Cinema Security Messages

Standardized Messages :

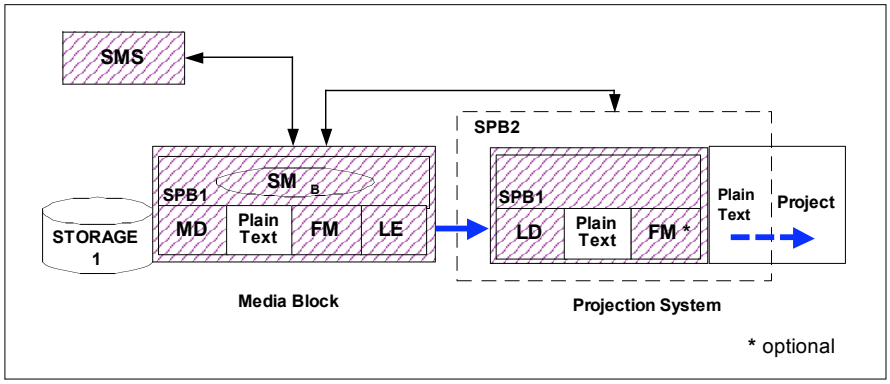
1. Extra -Theater Messages
2. Intra -Theater Messages



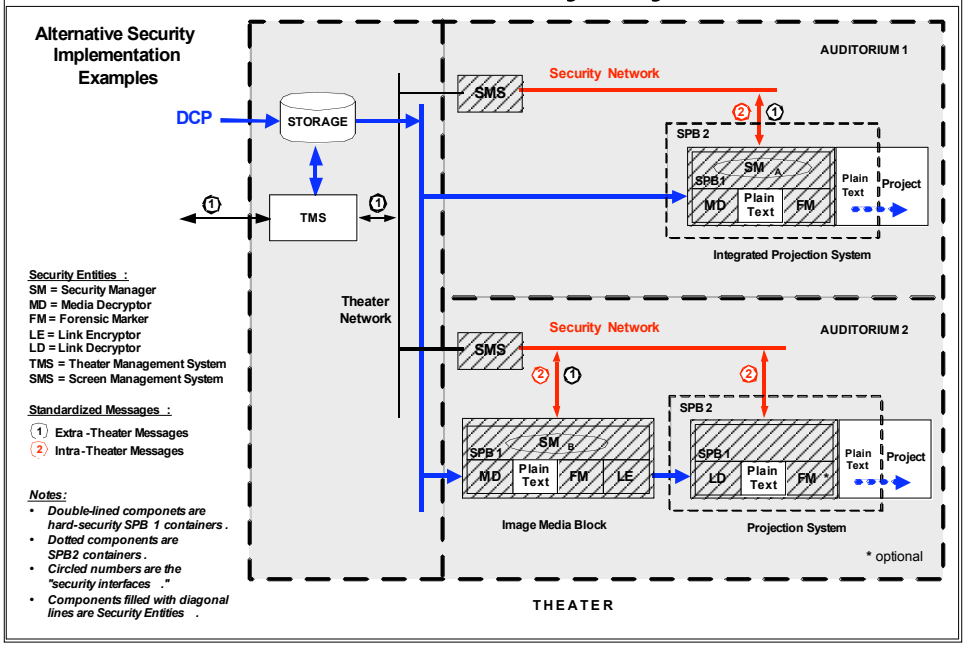
Integrated Projector Media Block

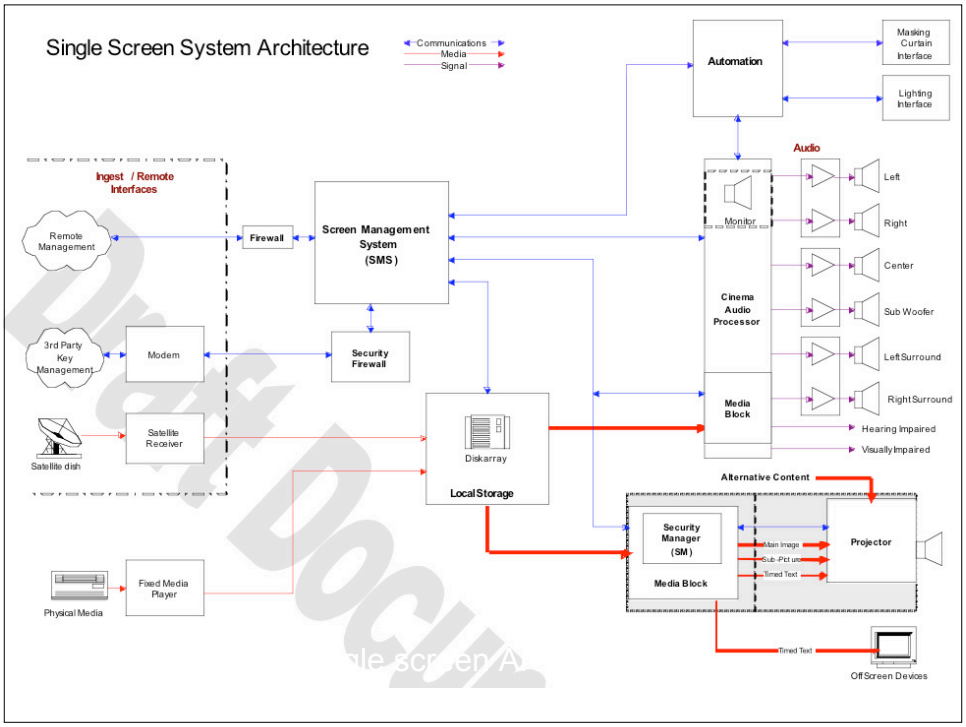


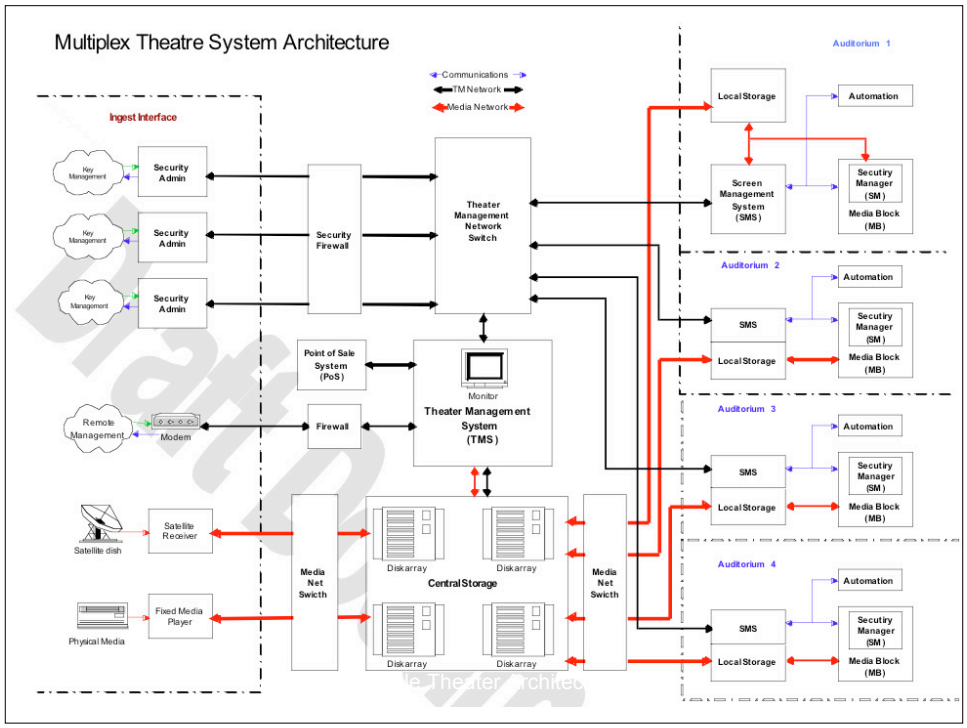
Media Block with Link Encryption



Theater Security System







Conclusions

- The future of distribution to the cinema will be digital
- We must have a new stable system in place for the long term future
- All seven major studios are supporting the DCI Specification
- We can't trade short term expediency for long term support