



Institut für Rundfunktechnik



SESSION 1

State of the Art on HDTV Technology in Production

Storage and archives for HDTV production

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SRG SSR *idée suisse*

Agenda

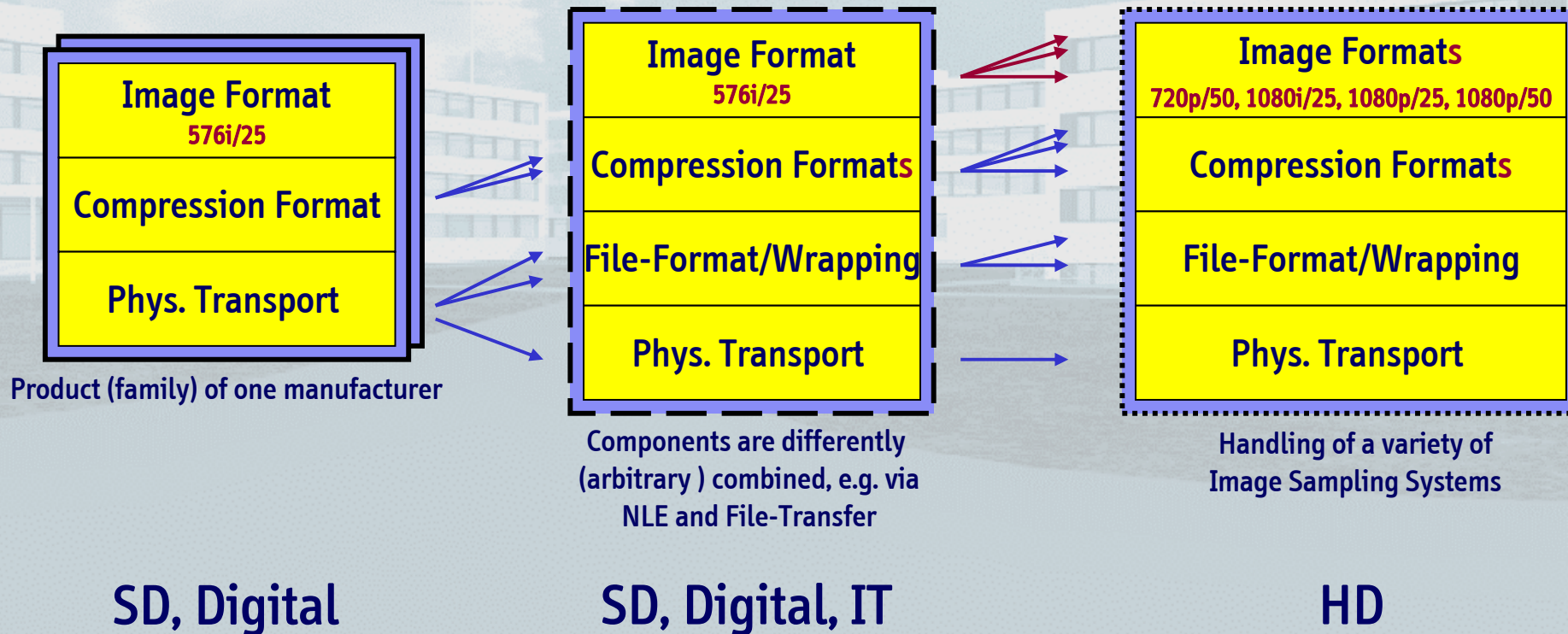


- HDTV storage
 - Peculiarities, sources and quantity to be stored
 - VTR's (video tape recorders)
 - NTBR's (non tape based recorders)
 - HDTV storage on Server
 - File formats
- Archive issues
- Conclusion

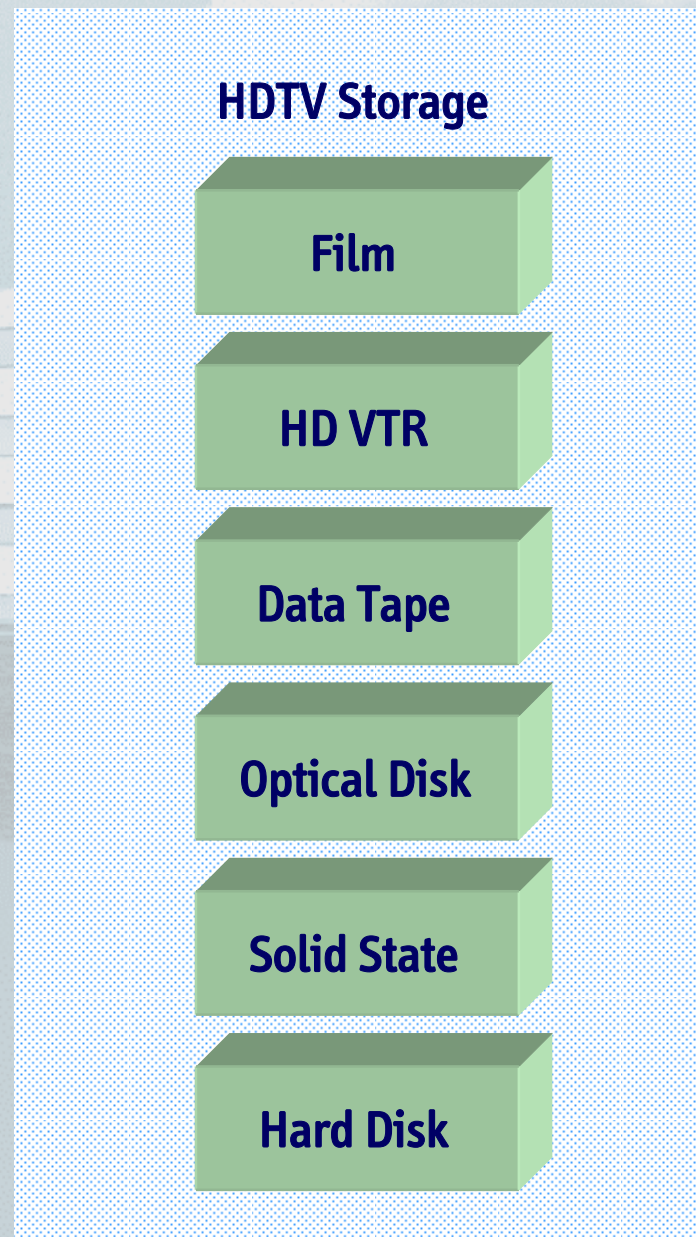
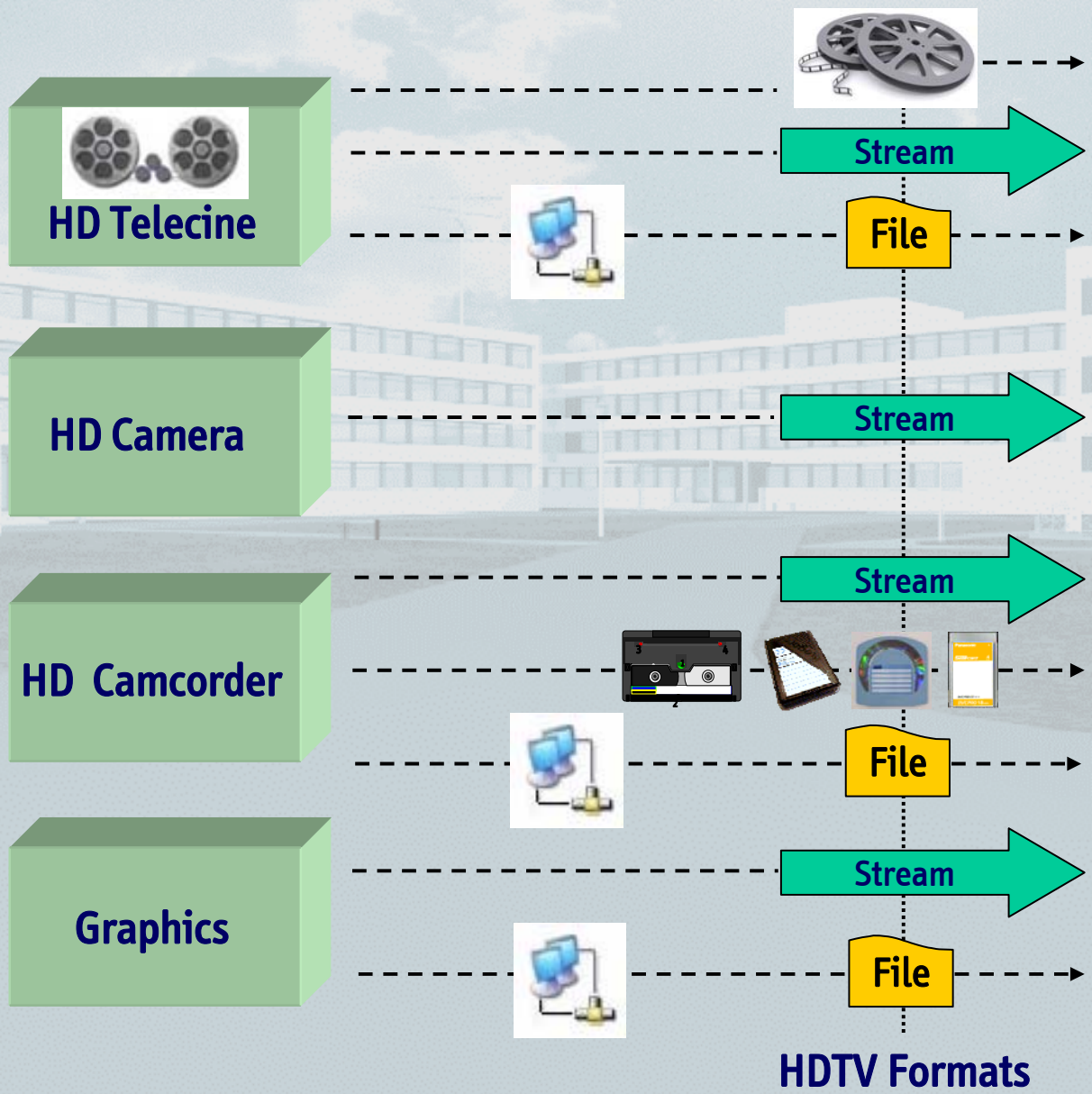
HDTV Storage - Peculiarities



Domestic Formats



HDTV Storage – Sources and Options



HDTV Storage – Relevant Interfaces

Analog RGB / YCbCr

Depending on the analogue source, e.g. according to SMPTE 274M

HD-SDI

SMPTE 292M

1.485 Gbit/s, 10 Bit, 4:2:2 HDTV Signals

DUAL HD-SDI

SMPTE 372M

defines a Dual Link Version of HD-SDI, e.g. 1080p/50

FireWire



IEEE 1394

0,1 to 0,79 Gbit/s, e.g. applied with DV and HDV camcorders

DVI

Defines a digital video interface (only RGB), supports analogue video signals, automatic setting of parameters between source and destination, optional content protection (HDCP)

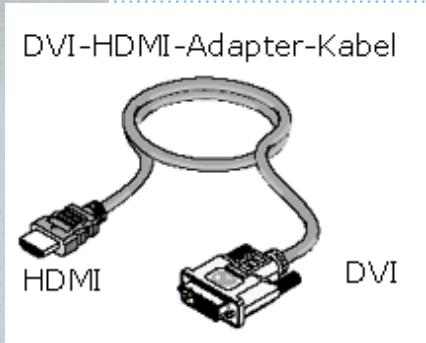
HDMI

HDMI is “DVI” plus digital sound, YCbCr colour space, and ...
No support for analogue video signals

SMPTE 3Gbit

Draft ITU and SMPTE

HD-SDI with 3 Gbit/s, e.g. 1080p/ 50-60, 4:2:2, 10 bit

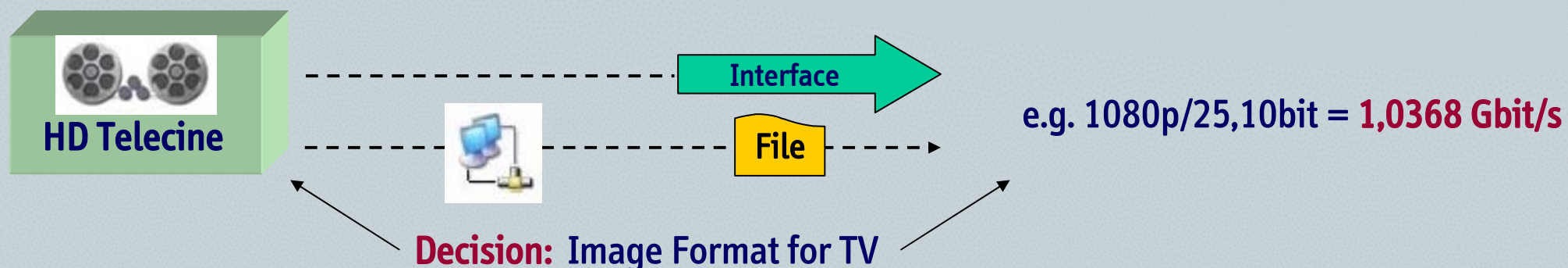


HDTV Storage – Film

Example: 35 mm Film (2K) in TV

Vertical:	1556 (4:3)	1152 (16:9)	lines
Horizontal:	2048	2048	samples per line
Total:	3 186 688	2 359 296	samples per image
Image frequency:	24	24	picture per second
Data quantity (RGB, 10 Bit):	2,294	1,699	Gbit/s

Film transferred into Video Domain



HDTV Storage – Quantity to be stored



System EBU Tech 3299 - E	Horizontal samples	Active lines	Frame rate	Colour sampling / Quantisation [Bit]		Net image Bit rate [Gbit/s]
System 1 720p/50	1280	720	50	4:2:2	10	0,9216
System 2 1080i/25	1920	1080	25	4:2:2	10	1,0368
System 3 1080p/25	1920	1080	25	4:2:2	10	1,0368
System 4 1080p/50	1920	1080	50	4:2:2	10	2,0736

HDTV Storage – VTR and NTBR Options

Domestic Video Tape Recorder – VTR



VHS HDTV

HDV-1/2

1/2" tape

1/4" tape

Professional Video Tape Recorder – VTR



HDCAM

DVCPRO HD

HD-D5

HDCAM-SR

Voodoo

1/2" tape

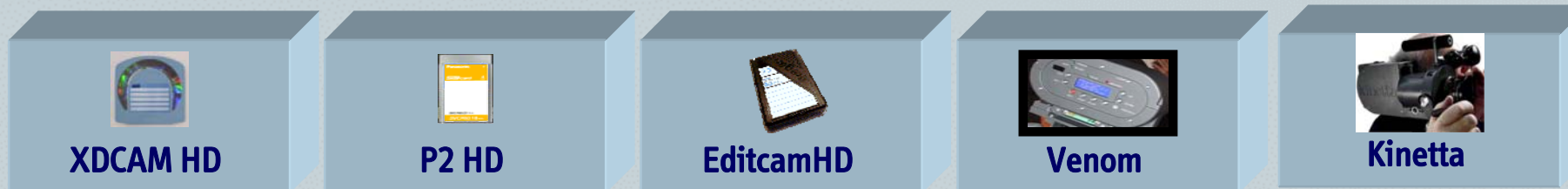
1/4" tape

1/2" tape

1/2" tape

3/4" tape

Non Tape Based Recorder - NTBR



XDCAM HD

P2 HD

EditcamHD

Venom

Kinetta

Optical Disk

FlasPak

Hard Disk,
FlashPak

FlashPak

Hard Disk

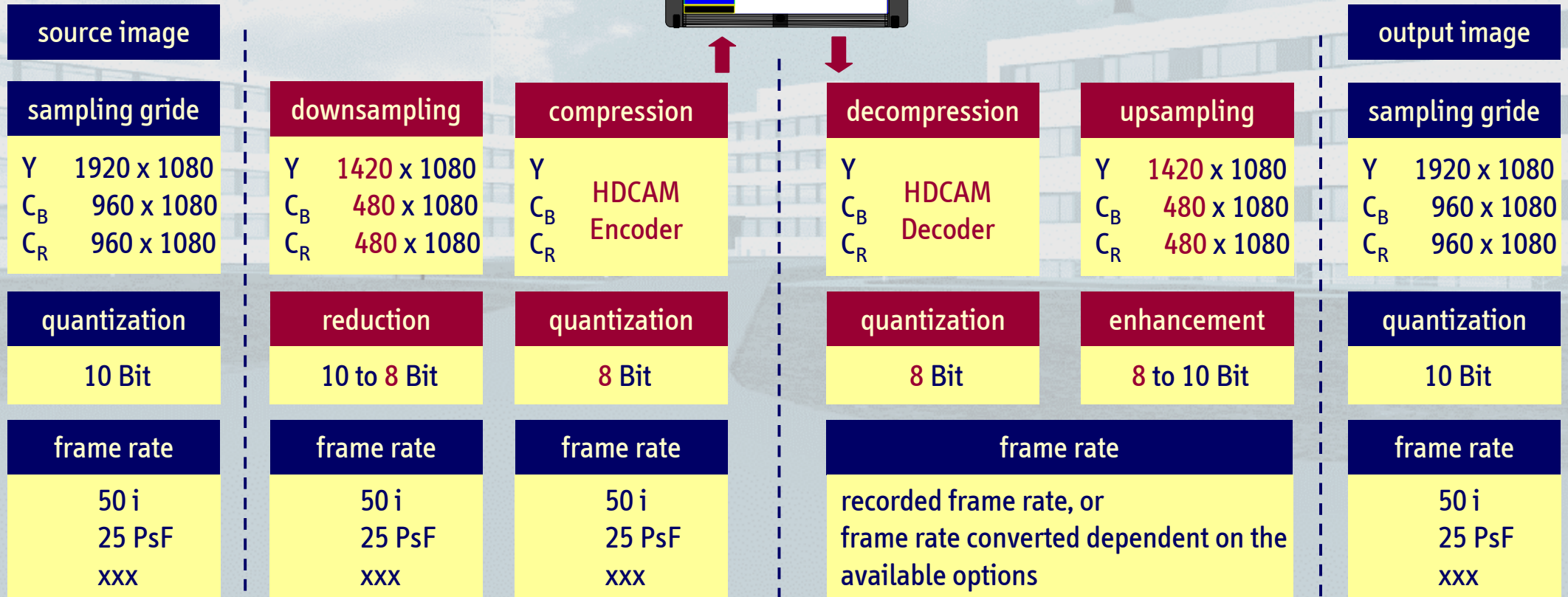
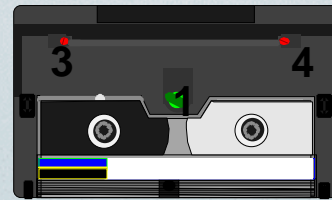
HDCAM (D-11)

Standard	SMPTE 367M, 368M
Resolution [x*y, frame]	1440 x 1080
Quantisation [Bit]	8
Frame Rates	<u>1080</u> p/24, p/25, p/30, i/30, i/25
Colour sub-sampling	3:1:1
Compression	~7:1*, Intra
Net video data rate [Mbit/s]	112 - 142
Interface (typical)	Tape, HD-SDI
File based	MXF Mapping specified
Audio channels	4 x 20 bit / 48 kHz



* calculated from 10 bit input signals

HD Video Tape Recorder - Peculiarities



DVCPRO HD (D-12)	
Standard	SMPTE 370M, 371M
Resolution [x*y, frame]	960 x 720 / 1440 x 1080
Quantisation [Bit]	8
Frame Rates	<u>720</u> p/50, p/60 <u>1080</u> i/30, i/25, i/24
Colour sub-sampling	4:2:2
Compression	~9:1*, Intra
Net video data rate [Mbit/s]	100
Interface (typical)	Tape, HD-SDI
File based	MXF Mapping specified
Audio channels	8 x 16 bit / 48 kHz



* calculated from 10 bit input signals

HD D-5 (D-15)

Standard	SMPTE 342M
Resolution [x*y, frame]	1920 x 1080 / 1280 x 720
Quantisation [Bit]	10
Frame Rates	1080 p/24, p/25, i/25, i/30 720 p/50, p/60
Colour sub-sampling	4:2:2
Compression	4,5 :1*, Intra
Net video data rate [Mbit/s]	235
Interface (typical)	Tape, HD-SDI
File based	MXF Mapping not available
Audio channels	8/4 x 20/24 bit / 48 kHz



* calculated from 10 bit input signals

HDCAM-SR (D-16)		New Option
Standard	SMPTE 409M	Not yet
Resolution [x*y, frame]	1920 x 1080 / 1280 x 720	1920 x 1080
Quantisation [Bit]	10	<- equal
Frame Rates	1080 p/24, p/25, p/30, i/25, i/30 720 p/50, p/60	1080 p/60, p/50
Colour sub-sampling	4:2:2	4:2:2, 4:4:4
Compression	2,3:1*, Intra	<- equal
Net video data rate [Mbit/s]	440	880
Interface (typical)	Tape, 2 x HD-SDI	<- equal
File based	MXF: MPEG-2 Mapping specified **	<- equal
Audio channels	12 x 24 bit / 48 kHz	



Field Recorder



* calculated from 10 bit input signals

** MPEG-2 mapping may be appropriate

VooDoo (D-6)

Standard	SMPTE 277M, 278M
Resolution [x*y, frame]	1920 x 1080
Quantisation [Bit]	Y 10 / Pb 8 / Pr 8
Frame Rates	1080 p/24, p/25, p/30, i/30, i/25
Colour sub-sampling	4:2:2
Compression	No
Net video data rate [Mbit/s]	995
Interface (typical)	Tape, HD-SDI, HiPPi
File based	MXF: uncompr. Mapping specified **
Audio channels	10/12 x 20bit / 48 kHz



** Uncompressed mapping may be appropriate





HDV	HDV-1	HDV-2
Standard	Draft IEC 61834-11	Draft IEC 61834-11
Resolution [x*y, frame]	1280 x 720	1440 x 1080
Quantisation [Bit]	8	8
Frame Rates	<u>720</u> p/25, p/30, p/50, p/60	<u>1080</u> i/30, i/25
Colour sub-sampling	4:2:0	4:2:0
Compression	~47:1*, Inter (GOP 6) (MPEG-2, MP@H-14, transport stream)	~41:1*, Inter (GOP 15) (MPEG-2, MP@H-14, elementary stream)
Net video data rate [Mbit/s]	19,3	25
Interface (typical)	Tape, FireWire	Tape, FireWire
File based	MXF: MPEG-2 Mapping specified **	MXF: MPEG-2 Mapping specified **
Audio channels	2 x MPEG-1 Audio Layer II (2 x 16 bit / 48 kHz)	2 x MPEG-1 Audio Layer II (2 x 16 bit / 48 kHz)

* calculated from 10 bit input signals

** MPEG-2 mapping may be appropriate

HDTV Storage – NTBR Non Tape Based Recorders



Optical Disk  XDCAM HD	1080i/variants as MPEG-2 Long-GOP, Data rates 35, 25 oder 18 Mbit/s, VBR
FlashPak  P2 HD	1080i/variants and 720p/variants of DVCPR0100 <i>! Future: Quality like HD-D5 utilizing new compression scheme (possibly H264?)</i>
Hard Disk, FlashPak  EditcamHD	1080i/variants and 720p/variants as Avid DNxHD 145 (future also: DNxHD220)
FlashPak  Venom	1080p/variants and 720p/variants (output of the Viper), <i>! 10 minutes of RGB 4:4:4@10bit, 18 minutes of YCbCr 4:2:2@10bit</i>
Hard Disk  Kinetta	1080p/24, uncompressed 10 bit log, claimed to store over 110 min per quick change magazine

HDTV Storage on Server



Thoughts on the topic: HDTV Storage on a “Server”

- take a high performance PC,
- an I / O- Board,
- a specific Software with GUI,
- a large Disk Storage System (TB)

Result: Ranging from pure HDTV storage to more or less useful editing capabilities - depending on the components selected

Increasing number of variants and suppliers available!

HDTV Storage – Editing Server

Just one example to illustrate the possibilities



- Real-time capture of up to 2K under the Windows® file system
- **Uncompressed RGB via dual-link interface**
- Conforming and editing of SD, HD, 2K & 4K in RGB 8/10/12/16 bit
- Tools for colour grading
- Clips of various formats on one timeline
- ...

Interfaces

- **SD-/HD-SDI input and output in YCbCr or RGB, 8/10/12* bit (single/dual link)**
- DVI output
- Analogue RGBS output, DVI connector
- SD down-converted output in PAL / NTSC
- 16 channels of 24-bit digital audio, 48 kHz I/O (AES/EBU and embedded audio)
- 2 analog stereo monitor outputs
- RS.422 master/slave operation

Video formats supported

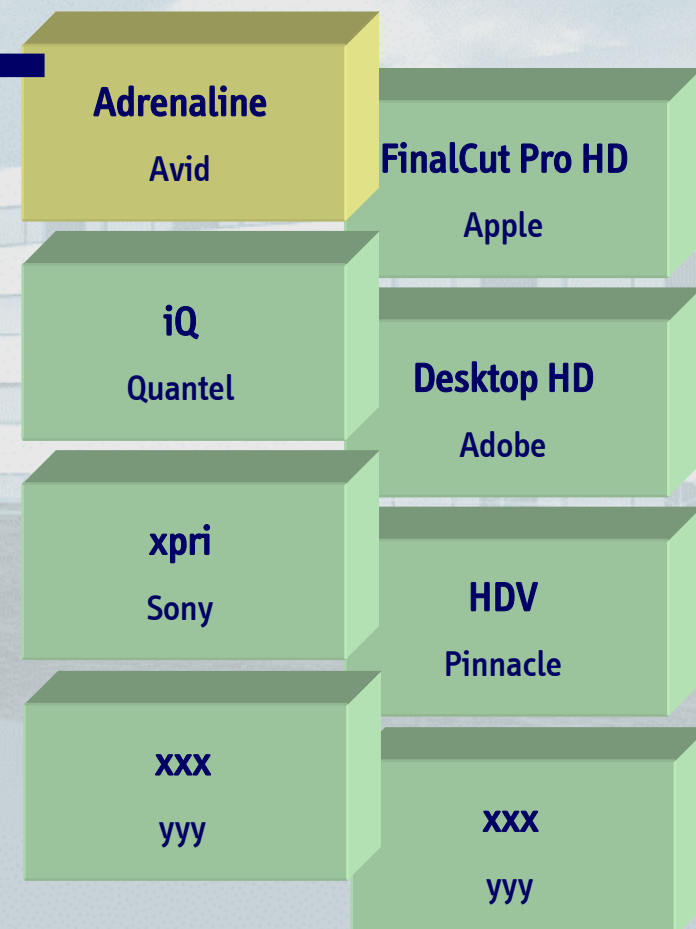
- SD: 625/50, 525/59,94
- HD: **1920x1080 @ many frame rates**
1280x720 @ many frame rates
- 2K: 2048x1556 @ 24p, 24 PsF, 48iFilm
- 4K: 4096x3112
- YCbCr 4:2:2, RGB 4:4:4
- Video formats in 8 / 10 / 12 / 16 bit
- ...

HDTV Storage – NLE Systems

Introduction of another compression scheme!

DNxHD 145 / 220	
Standard	SMPTE - proposed for Standard
Resolution [x*y, frame]	1920 x 1080 / 1280 x 720
Quantisation [Bit]	8 to 10
Frame Rates	<u>1080</u> p/24, p/25, i/25 <u>720</u> p/60, p50
Colour sub-sampling	4:2:2
Compression	e.g. 4:1*, Intra
Net video data rate [Mbit/s]	145 - 220
File based	MXF Mapping planned

Example



* calculated from 10 bit input signals

HD Storage Fileformat – Restrictions

You may find the following remarks



... the following file formats can be **used only** if your system is configured according to ...



... please note that video data stored in file formats may not be identical to the data on the video hard disk array. When you transfer video data from system disks to video hard disks and vice versa, it may be subject to a **colour space conversion**



... it supports resolution independency, but **does not contain** sound data or metadata

Pay attention to the intended task/designation of the file format concerned:

- just for exchange, e.g. video, audio, TC, data, etc.
- just for storage

HD Storage Fileformat – Differentiation

“Pure Image” Fileformat

Sound and data information is not incorporated and producers must manage soundtracks, TC and metadata separately

“Content” Fileformat

Overcomes the limitations by, for instance, support of multiple soundtracks and by support of Metadata and ID's

“Specialised” Fileformat

It may have been tailored to more narrow, specific purposes, by comprising already system or/and image components

“Generalised” Fileformat (Wrapper)

Basically a wrapper which is format independent and just encapsulates and synchronises its constituent bit streams

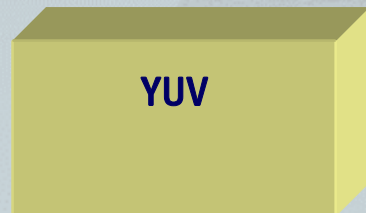
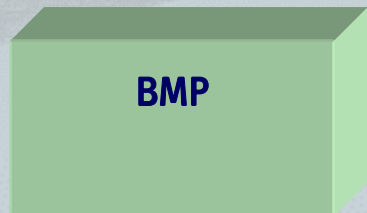
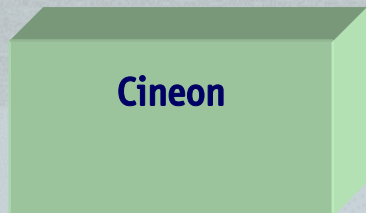
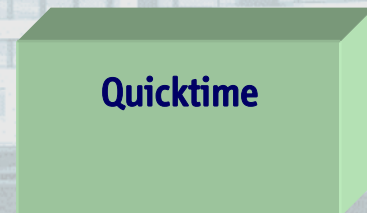
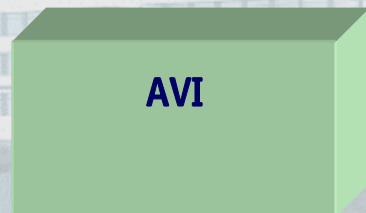
HD Storage Fileformat – Peculiarities

Example: MXF is a Wrapper and a Content Fileformat

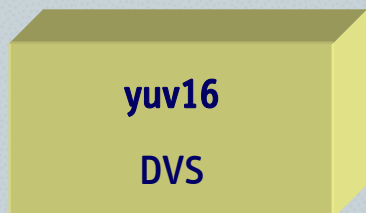


Mappings are specified for: Uncompressed RGB, YCbCr; D-6 (VooDoo), D-11 (HDCAM), HDV (MPEG), HDCAM-SR (MPEG-4, SMPTE 382), MPEG-2 HL, ...

Selection of wrappers and formats actual used for HDTV storage



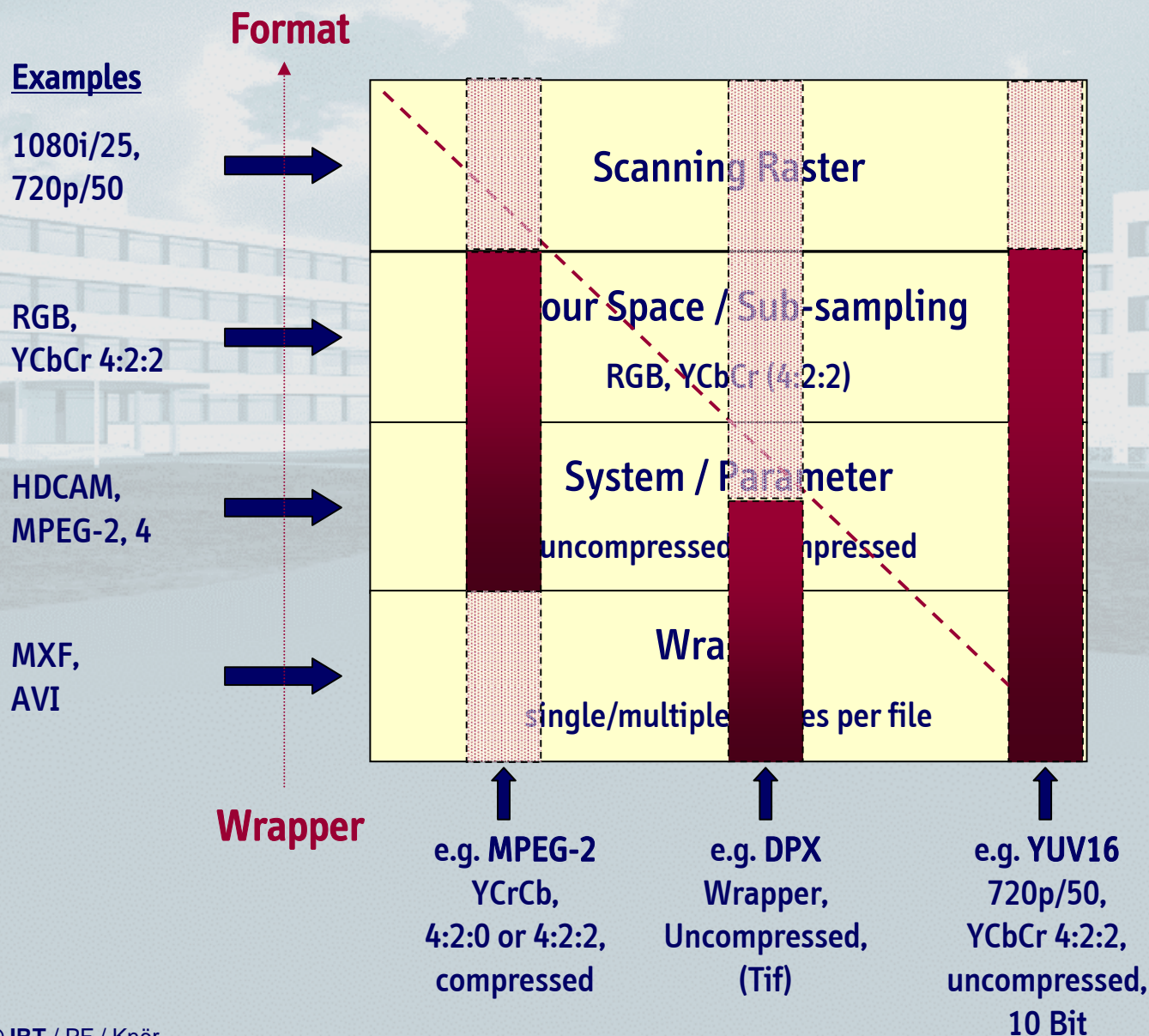
Example: Specific implementation of “YUV” representing “Pure Image” + “Specialised” Fileformat



Raw 16 bit YCbCr 422 format. This file has no header. Each component is stored as a 16 bit value. Component order UYVY. One file per frame.

Contains NO information about its composition!

HDTV Storage – Wrapper and Format



Compression / Image Format

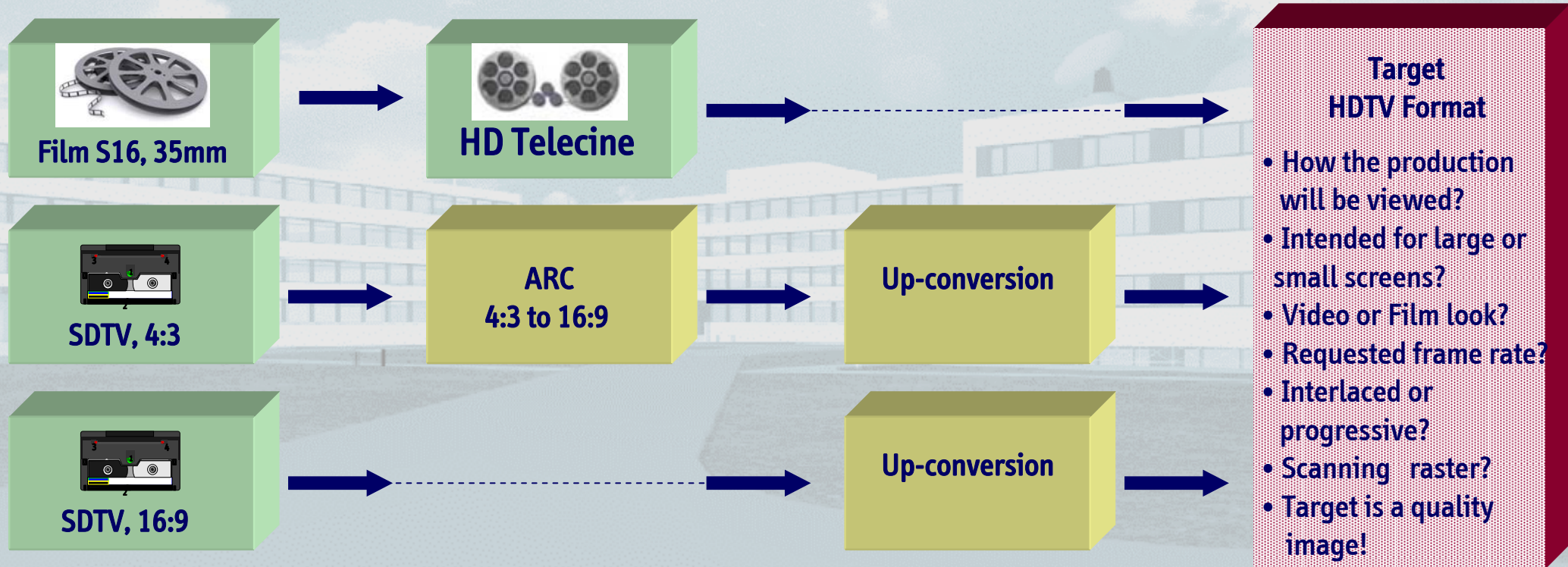
	1	2	3	4
A		X	X	
B	X	X		
C	X	X	X	X
D		X	X	

Wrapper

By Courtesy of Dr. Höntschi, IRT
Chair P/TV-File

Reuse and insertion of SDTV material into HDTV

How much SD material will allowed in each programme?



- Target HDTV Format**
- How the production will be viewed?
 - Intended for large or small screens?
 - Video or Film look?
 - Requested frame rate?
 - Interlaced or progressive?
 - Scanning raster?
 - Target is a quality image!

- Poor quality images may require electronic cleaning
- Costly

- Quality impaired by the ARC process
- ARC may be necessary scene by scene
- Costly

- Adds to the quality impairment
- Best practices required
- Relatively expensive

- With HDTV planning is more important than with SDTV
- Financially/technically risks

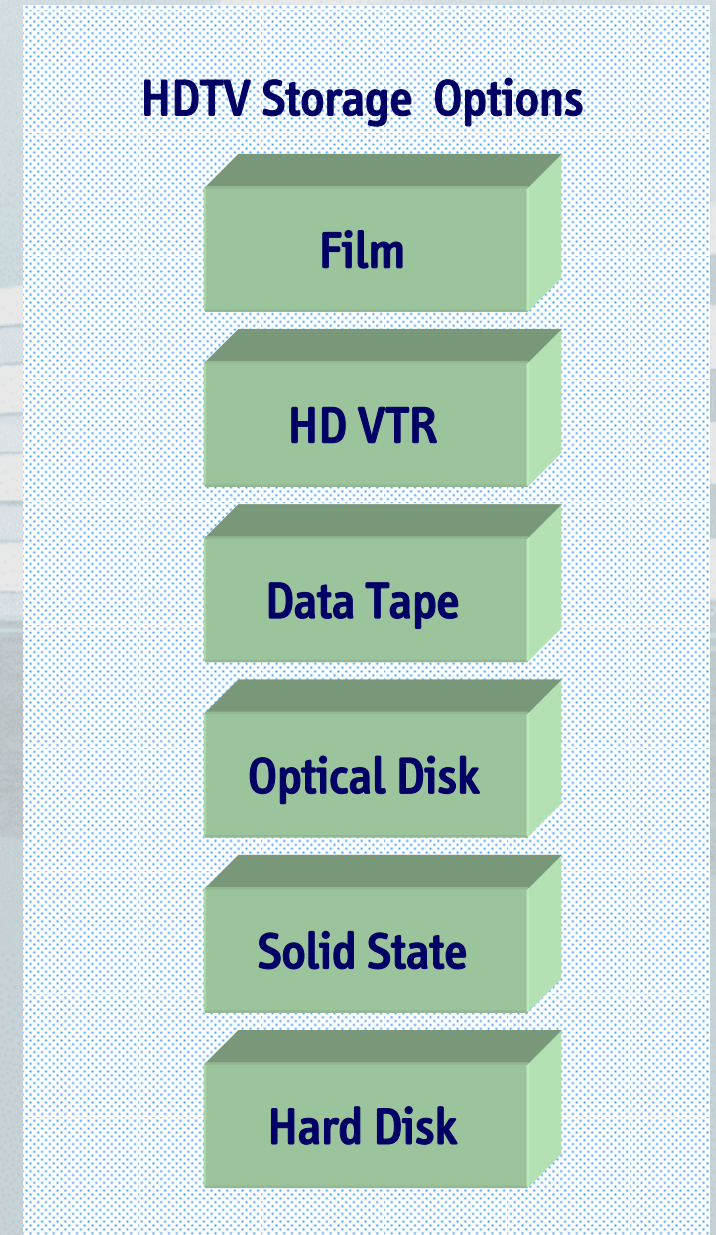
HDTV Archives – Format and Content quality

1. Which Format / Carrier?

- Intended life cycle of the Content – long term or less?
- Formats, e.g. carriers, file formats, compression schemes, etc., that are promising for long-term durability?
- Strategies for sustaining these formats!

2. Requirements concerning the technical quality of the Content to be archived

- Which quality impairment will be acceptable?
 - Scanning raster conversions
 - Frame rate conversions
 - Compression schemes involved
 - ...
- How many lossy processes have been concatenated during content creation?
- Expected repurposing possible in the future?



Demo



Will we make the same Mistakes again?

Example

New Quality Reference at Domestic hands!

Example

Conclusions

- HDTV storage offers so many options - a “small” user have never dreamed off!!!
- Selection of the right tools becomes more complicated
 - Multiple image formats to deal with
 - Great variety of different compression schemes and data rates
 - Varying file formats for exchange and storage
 - What is going to be acceptable for archiving
- “Best practises” production grammar may/will help
- Let's tackle it!

Thank you!

Production Systems Television

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