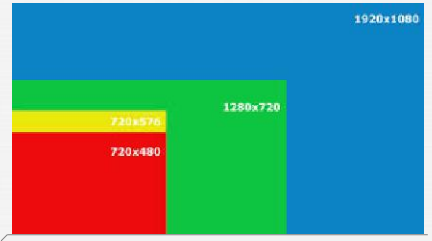
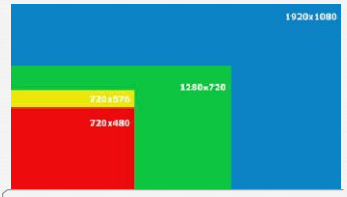
Characteristics of a digital video file

- Container
  - A container is like a drawer, with 3 parts
  - Generic containers
  - Specific containers
- Codec
  - Codec is a way to record less informations (Compression), and, at the moment of the playing, rebuild a whole picturer (Decompression) : Co-Dec
  - Still pictures
  - Video
  - Audio
  - Families
- Color space
  - RGB Color space
  - CMYK
  - YUV
  - XYZ
- Bit depth
  - 8 bits
  - 9 bits
  - 10 bits
  - 12 bits
- Bit rate
  - DV Format
  - DVD video
- Definition



  - This is the number of pixels of the picture
  - "Resolution"
  - Digital video
  - Computers
  - Digital Cinema
- Aspect ratio
  - Video
  - General Cinema
  - Digital Cinema
- Digital media
  - Mini DV
  - DVD video
    - 4,5 GBytes on a DVD
    - With double layer : 8,5 GBytes
  - Digital Betacam
  - HDCAM
- Frame rate
  - Number of pictures per second
  - Cinema
  - Television
  - Others
  - Computers
  - If you want slow motion, shoot more fps than you project
- Audio
  - How to digitize analog audio
  - Formats
  - Number of tracks
  - Bitrates of audio
  - Codecs
- Progressive / Interlaced
  - Interlaced
  - Progressive
  - **50i**
  - **25p**

Characteristics of a digital video file



This is the number of pixels of the picture

"Resolution"
- It's another thing
- The number of pixels printed in a specific size on paper
- ex : 300dpi

Digital video

Definition

HD

1920x1080 (High Definition)
- 2 073 600 pixels
- 2 Mpixels pictures (2 million pixels)
- "Full HD" (commercial name)
- Each pixel is a square
- Aspect ratio : 1,78

1280x720
- "HD ready" (commercial name)
- Each pixel is a square
- Aspect ratio : 1,78
- 921 600 pixels
- 1 Mpixels
- We can use it, but it's a bit past
- It's a useful for showing movies with computers
- Vimeo encodes into this definition

1440x1080
- HDV
  - Appeared in 1996
  - Is the evolution of the DV, the HD version of the DV
- It's anamorphic
  - The pixels are not squares
  - They are rectangles as in HD
  - 1,33 for each pixel, to simulate the 1920 large
- There is a metadata to tell to the player to change the aspect ratio of the pixel
- Avoid it at shooting stage if you can : be careful in the menu of the camera

SD

Standard Definition
- The pixel is not a square, it's a rectangle
- 414 720 pixels — 0,4 Mpixels

720x576
- Devices
  - DVD
  - TV
  - Mini DV
  - DVCAM
  - Digital Betacam
- Two aspect ratios
  - 4/3
    - Each pixel is 1,09 large
    - So, the aspect ratio, if the pixels were squares, sould be 1,25, but with 1,09 large for each, the aspect ratio becomes 1,33
    - If the pixels were squares, the right definition would be 768x576
  - 16/9
    - Each pixel is 1,46 large
    - So, the aspect ratio, if the pixels were squares, sould be 1,25, but with 1,46 large for each, the aspect ratio becomes 1,78
    - If the pixels were squares, the right definition would be 1024x576

- There is a metadata, that tells if it's 4/3 or 16/9 — Depend on it, the aspect ratio of the pixel will be changed

Computers
- Always square pixels
- Computer screens
  - 1024x768
  - 800x600
- Size of video
  - 320x240 — Youtube size the first years
  - 640x480 — It's a bit better
  - 352x288 — VCD
    - Still used in Africa as a distribution format (au Cameroun et au Burkina, non, c'est le DVD)
    - Burned on CD (not DVD), so much cheaper
    - Square pixels
  - 172x144 — The earlier mobile phones (format of visiophony)

Digital Cinema

2K
- Is the nowadays standard
- Number of pixels of the matrix in the projector — 2048x1080
- Square pixels
- FLAT — 1,85 aspect ratio — 1998x1080 pixels
- SCOPE — 2,39 aspect ratio — 2048x858 pixels

4K
- 4096x2160
- Is the standard for shooting features, and will become the standard for DCPs

6K
- Is for scanning and restoring 35mm movies
- 6144x3240

8K
- Is for scanning and restoring 65mm movies
- 8192x4320

Characteristics of a digital video file

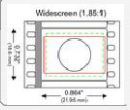
- Aspect ratio
  - Video
    - SD
      - Two aspect ratios
      - 4/3
        - If the picture is 1 tall, it will be 1,33 large
      - 16/9
        - If the picture is 1 tall, it will be 1,78 large
        - Sometimes, it's named 1,77 : it's the same thing
      - "False 16/9" : put black bars into a 4/3 picture

        - Problem when looking in full screen on an 16/9 screen
        - Be very careful at the export stage (especially "web" exports) that the software doesn't create 4/3 aspect ratio video
      - Bars
        - Top & bottom : LETTERBOX

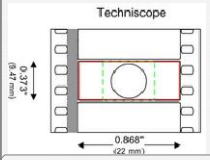
        - Left & right : PILLARBOX

    - HD
      - Only one aspect ratio
      - 16/9
  - General Cinema
    - 1,33
      - The first one, silent cinema
      - 1895
    - 1,37
      - The old one, talking cinema
      - 1927

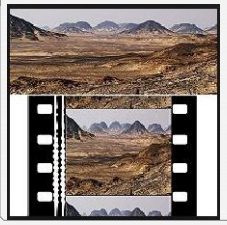
    - 1,66
      - Super 16
      - 70's format
      - Used because cheaper for ending in 35mm
    - 1,85
      - '80s format
      - Panoramic
      - Was used in 35mm, and is always used in Digital Cinema



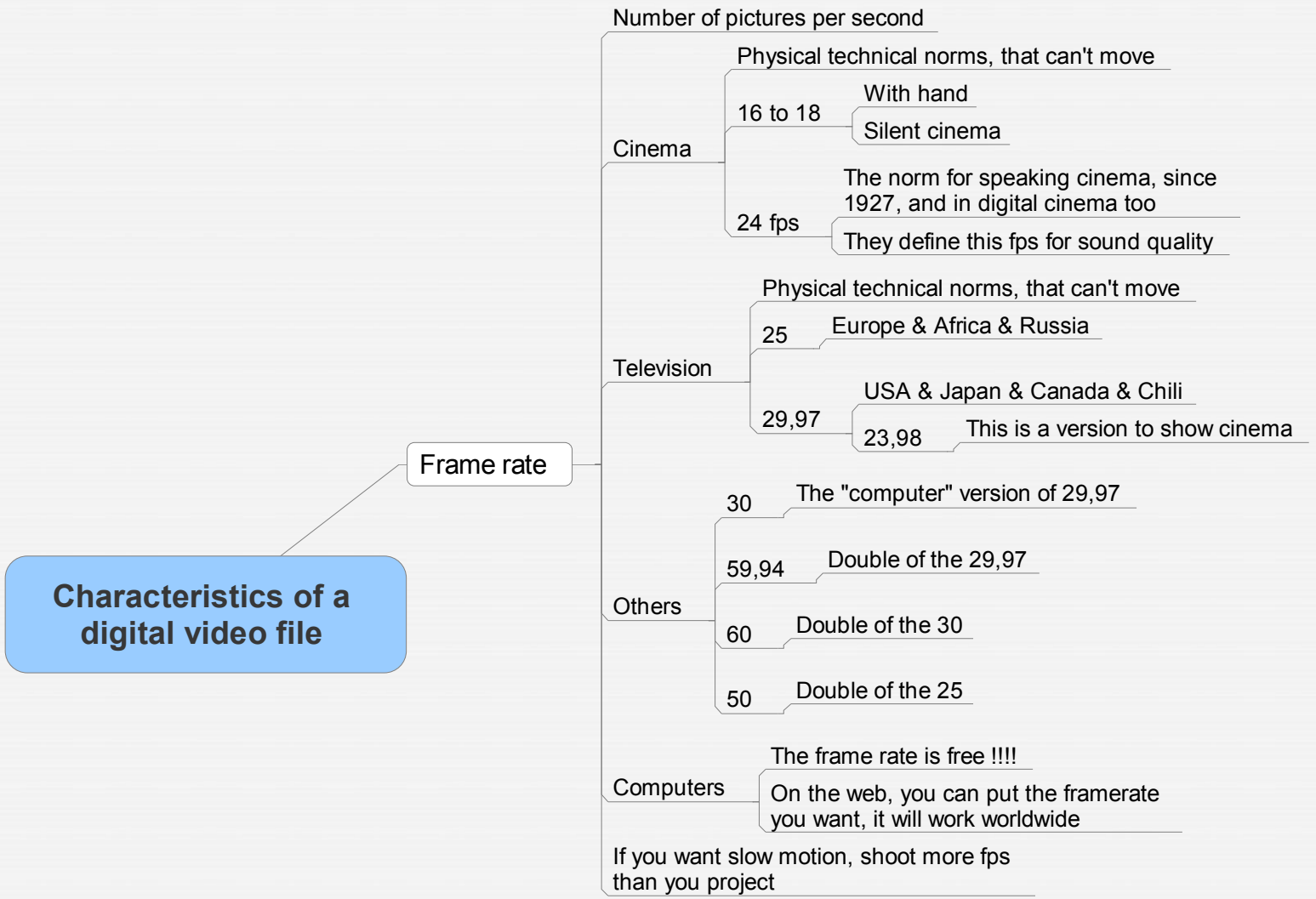
    - 2,21
      - ???
    - 2,35
      - '90s format
      - Cinemascope
      - 35mm format

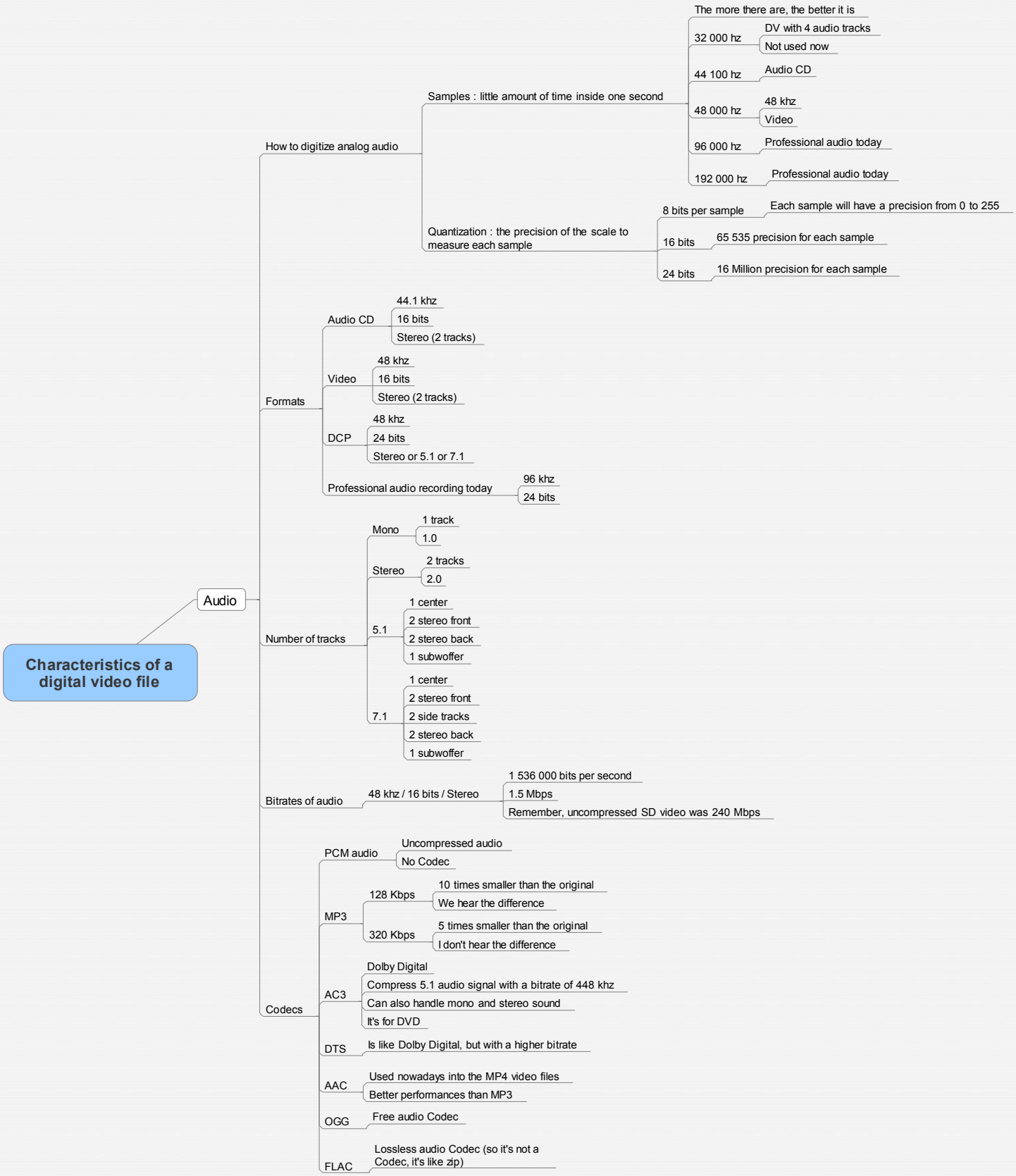


      - No : we loose too much space



      - Yes, with an anamorphic lens on the camera and on the projector, we use all the space on the film to record the picture
    - 2,39
      - Digital Cinemascope
  - Digital Cinema
    - 1,85
      - FLAT
      - 1998x1080
    - 2,39
      - SCOPE
      - 2048x858


Characteristics of a digital video file
Frame rate
Number of pictures per second
Cinema
Physical technical norms, that can't move
16 to 18
With hand
Silent cinema
24 fps
The norm for speaking cinema, since 1927, and in digital cinema too
They define this fps for sound quality
Television
Physical technical norms, that can't move
25
Europe & Africa & Russia
29,97
USA & Japan & Canada & Chili
23,98
This is a version to show cinema
Others
30
The "computer" version of 29,97
59,94
Double of the 29,97
60
Double of the 30
50
Double of the 25
Computers
The frame rate is free !!!!
On the web, you can put the framerate you want, it will work worldwide
If you want slow motion, shoot more fps than you project


Characteristics of a digital video file
Audio
How to digitize analog audio
Samples : little amount of time inside one second
The more there are, the better it is
32 000 hz
DV with 4 audio tracks
Not used now
44 100 hz
Audio CD
48 000 hz
48 khz
Video
96 000 hz
Professional audio today
192 000 hz
Professional audio today
Quantization : the precision of the scale to measure each sample
8 bits per sample
Each sample will have a precision from 0 to 255
16 bits
65 535 precision for each sample
24 bits
16 Million precision for each sample
Formats
Audio CD
44.1 khz
16 bits
Stereo (2 tracks)
Video
48 khz
16 bits
Stereo (2 tracks)
DCP
48 khz
24 bits
Stereo or 5.1 or 7.1
Professional audio recording today
96 khz
24 bits
Number of tracks
Mono
1 track
1.0
Stereo
2 tracks
2.0
5.1
1 center
2 stereo front
2 stereo back
1 subwoffer
7.1
1 center
2 stereo front
2 side tracks
2 stereo back
1 subwoffer
Bitrates of audio
48 khz / 16 bits / Stereo
1 536 000 bits per second
1.5 Mbps
Remember, uncompressed SD video was 240 Mbps
Codecs
PCM audio
Uncompressed audio
No Codec
MP3
128 Kbps
10 times smaller than the original
We hear the difference
320 Kbps
5 times smaller than the original
I don't hear the difference
AC3
Dolby Digital
Compress 5.1 audio signal with a bitrate of 448 khz
Can also handle mono and stereo sound
It's for DVD
DTS
Is like Dolby Digital, but with a higher bitrate
AAC
Used nowadays into the MP4 video files
Better performances than MP3
OGG
Free audio Codec
FLAC
Lossless audio Codec (so it's not a Codec, it's like zip)

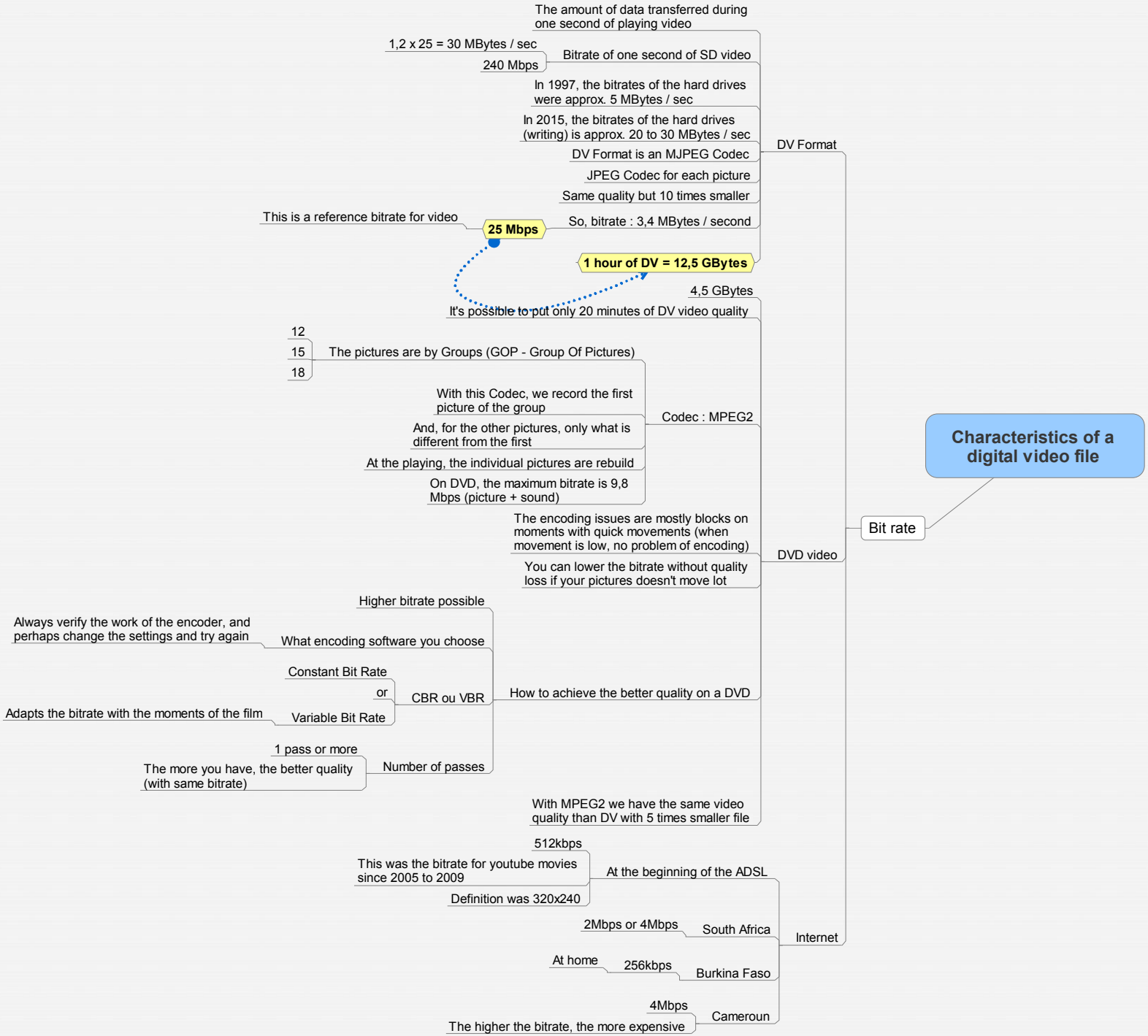
Characteristics of a digital video file

Progressive / Interlaced

Interlaced

Progressive

- **50i** — **Interlaced**
- **25p** — **Progressive**


Characteristics of a digital video file
Bit rate
DV Format
The amount of data transferred during one second of playing video
Bitrate of one second of SD video
1,2 x 25 = 30 MBytes / sec
240 Mbps
In 1997, the bitrates of the hard drives were approx. 5 MBytes / sec
In 2015, the bitrates of the hard drives (writing) is approx. 20 to 30 MBytes / sec
DV Format is an MJPEG Codec
JPEG Codec for each picture
Same quality but 10 times smaller
So, bitrate : 3,4 MBytes / second
This is a reference bitrate for video
25 Mbps
1 hour of DV = 12,5 GBytes
4,5 GBytes
It's possible to put only 20 minutes of DV video quality
DVD video
Codec : MPEG2
12
15
18
The pictures are by Groups (GOP - Group Of Pictures)
With this Codec, we record the first picture of the group
And, for the other pictures, only what is different from the first
At the playing, the individual pictures are rebuild
On DVD, the maximum bitrate is 9,8 Mbps (picture + sound)
The encoding issues are mostly blocks on moments with quick movements (when movement is low, no problem of encoding)
You can lower the bitrate without quality loss if your pictures doesn't move lot
How to achieve the better quality on a DVD
Higher bitrate possible
What encoding software you choose
Always verify the work of the encoder, and perhaps change the settings and try again
CBR ou VBR
Constant Bit Rate
or
Variable Bit Rate
Adapts the bitrate with the moments of the film
Number of passes
1 pass or more
The more you have, the better quality (with same bitrate)
With MPEG2 we have the same video quality than DV with 5 times smaller file
Internet
At the beginning of the ADSL
512kbps
This was the bitrate for youtube movies since 2005 to 2009
Definition was 320x240
South Africa
2Mbps or 4Mbps
Burkina Faso
At home
256kbps
Cameroun
4Mbps
The higher the bitrate, the more expensive

Characteristics of a digital video file

Bit depth

8 bits

The number of bits for each color

256 nuances possible per color

Not so much

Especially with black & white

Black and white

One picture from a DV video

720x576 pixels

414 720 pixels

Size of the file should be 414 720 bits

51 840 Bytes

51,8 KB

Because there are metadatas

The real size of the file is 53 056 Bytes

It's a picture

It's 720x576 pixels

It's black & white

So all the Bytes after me (the metadata) has to be used as individual black and white pixels

The metadata are written in the .BMP format specific language

Greyscale

720x576 pixels

For each pixel, 256 possible nuances

1 Byte for each pixel

8 bits for each pixel

414 720 pixels

Size of the file

414 720 x 8 = 3 317 760 bits

414 720 Bytes

406 KB

Color

720x576 pixels

For each pixels, 256 nuances of RED, 256 nuances of GREEN, 256 nuances of BLUE

So, 1 Byte for each color of each pixel, so 3 Bytes for each pixel

24 bits for each pixel

414 720 pixels

Size of the file

9 Million bits

1 244 160 Bytes

1,18 MBytes

For each pixel, 16 million colors possible

9 bits

In theory (because not used in video)

512 nuances per color

10 bits

Used in video

1024 nuances per color

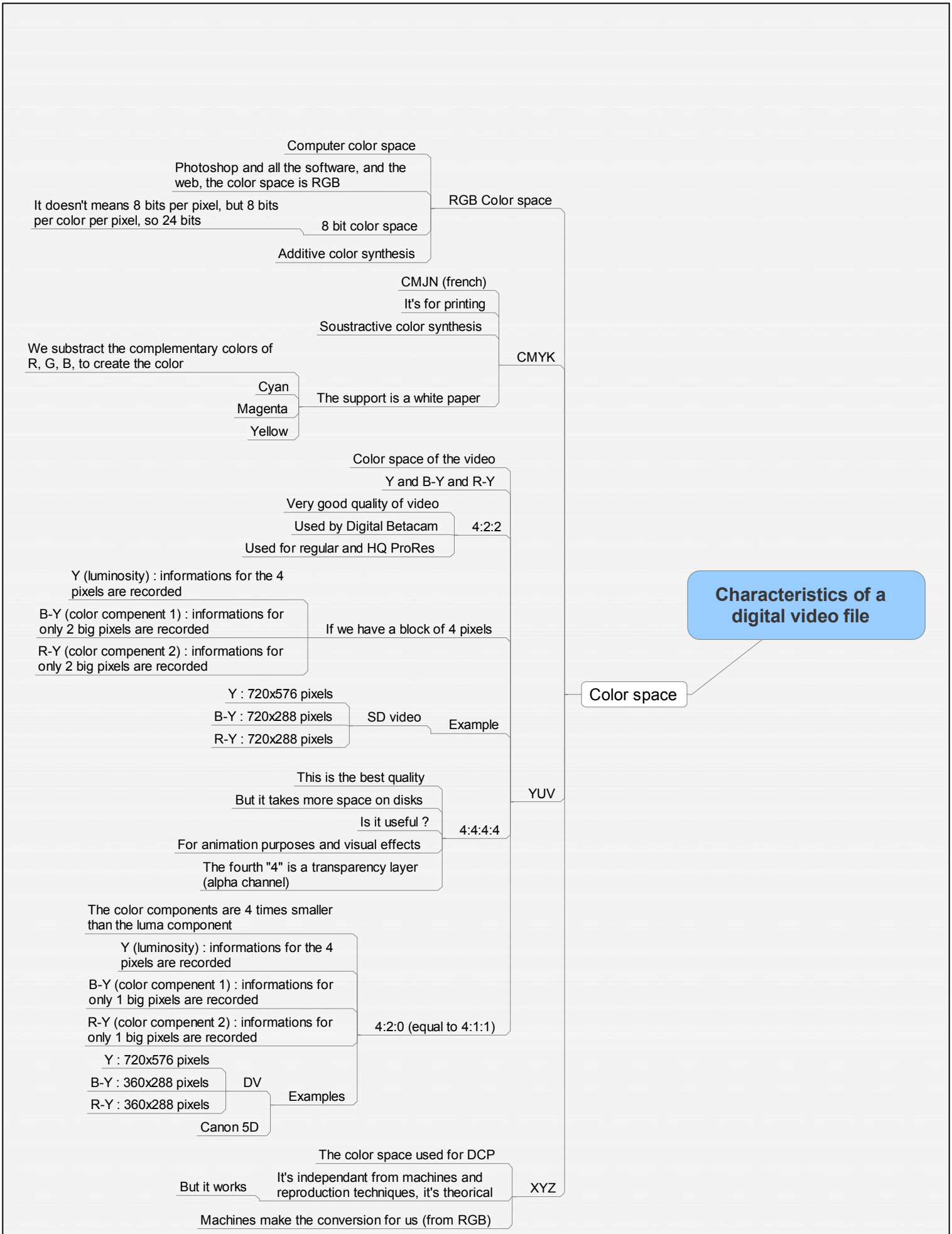
Used by Digital Betacam

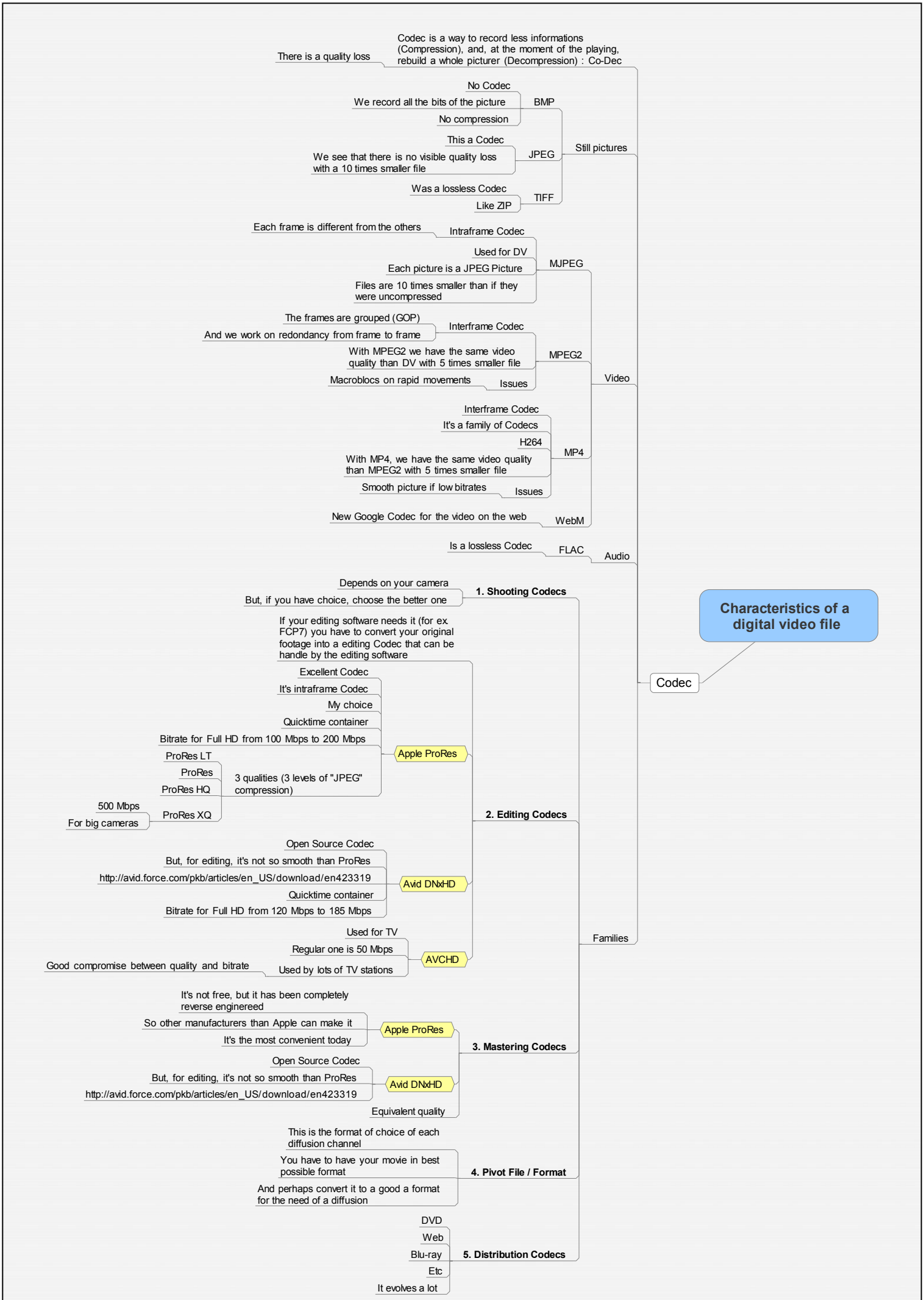
Used by ProRes codec

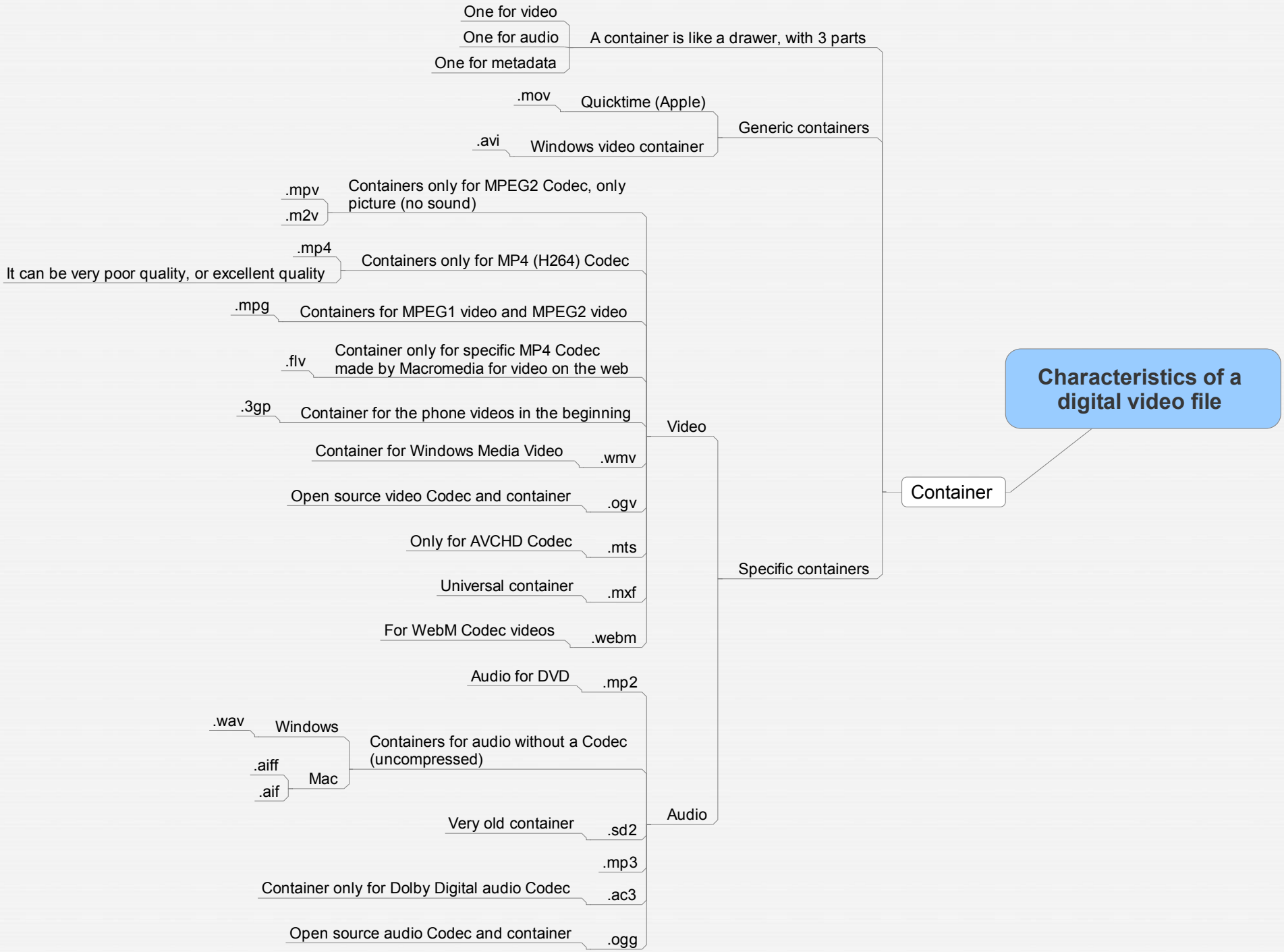
12 bits

4096 nuances per color

Used for DCP


Characteristics of a digital video file
Color space
RGB Color space
Computer color space
Photoshop and all the software, and the web, the color space is RGB
8 bit color space
It doesn't means 8 bits per pixel, but 8 bits per color per pixel, so 24 bits
Additive color synthesis
CMYK
CMJN (french)
It's for printing
Soustractive color synthesis
We substract the complementary colors of R, G, B, to create the color
The support is a white paper
Cyan
Magenta
Yellow
YUV
Color space of the video
Y and B-Y and R-Y
4:2:2
Very good quality of video
Used by Digital Betacam
Used for regular and HQ ProRes
If we have a block of 4 pixels
Y (luminosity) : informations for the 4 pixels are recorded
B-Y (color compenent 1) : informations for only 2 big pixels are recorded
R-Y (color compenent 2) : informations for only 2 big pixels are recorded
Example
SD video
Y : 720x576 pixels
B-Y : 720x288 pixels
R-Y : 720x288 pixels
4:4:4:4
This is the best quality
But it takes more space on disks
Is it useful ?
For animation purposes and visual effects
The fourth "4" is a transparency layer (alpha channel)
4:2:0 (equal to 4:1:1)
The color components are 4 times smaller than the luma component
Y (luminosity) : informations for the 4 pixels are recorded
B-Y (color compenent 1) : informations for only 1 big pixels are recorded
R-Y (color compenent 2) : informations for only 1 big pixels are recorded
Examples
DV
Y : 720x576 pixels
B-Y : 360x288 pixels
R-Y : 360x288 pixels
Canon 5D
XYZ
The color space used for DCP
But it works
It's independant from machines and reproduction techniques, it's theorical
Machines make the conversion for us (from RGB)


Characteristics of a digital video file
Codec
Codec is a way to record less informations (Compression), and, at the moment of the playing, rebuild a whole picturer (Decompression) : Co-Dec
There is a quality loss
Still pictures
BMP
No Codec
We record all the bits of the picture
No compression
JPEG
This a Codec
We see that there is no visible quality loss with a 10 times smaller file
TIFF
Was a lossless Codec
Like ZIP
Video
MJPEG
Intraframe Codec
Each frame is different from the others
Used for DV
Each picture is a JPEG Picture
Files are 10 times smaller than if they were uncompressed
MPEG2
Interframe Codec
The frames are grouped (GOP)
And we work on redondancy from frame to frame
With MPEG2 we have the same video quality than DV with 5 times smaller file
Issues
Macroblocs on rapid movements
MP4
Interframe Codec
It's a family of Codecs
H264
With MP4, we have the same video quality than MPEG2 with 5 times smaller file
Issues
Smooth picture if low bitrates
WebM
New Google Codec for the video on the web
Audio
FLAC
Is a lossless Codec
Families
1. Shooting Codecs
Depends on your camera
But, if you have choice, choose the better one
2. Editing Codecs
If your editing software needs it (for ex. FCP7) you have to convert your original footage into a editing Codec that can be handle by the editing software
Apple ProRes
Excellent Codec
It's intraframe Codec
My choice
Quicktime container
Bitrate for Full HD from 100 Mbps to 200 Mbps
ProRes LT
ProRes
ProRes HQ
3 qualities (3 levels of "JPEG" compression)
ProRes XQ
500 Mbps
For big cameras
Avid DNxHD
Open Source Codec
But, for editing, it's not so smooth than ProRes
http://avid.force.com/pkb/articles/en_US/download/en423319
Quicktime container
Bitrate for Full HD from 120 Mbps to 185 Mbps
AVCHD
Used for TV
Regular one is 50 Mbps
Used by lots of TV stations
Good compromise between quality and bitrate
3. Mastering Codecs
Apple ProRes
It's not free, but it has been completely reverse engineered
So other manufacturers than Apple can make it
It's the most convenient today
Avid DNxHD
Open Source Codec
But, for editing, it's not so smooth than ProRes
http://avid.force.com/pkb/articles/en_US/download/en423319
Equivalent quality
4. Pivot File / Format
This is the format of choice of each diffusion channel
You have to have your movie in best possible format
And perhaps convert it to a good a format for the need of a diffusion
5. Distribution Codecs
DVD
Web
Blu-ray
Etc
It evolves a lot


Characteristics of a digital video file
Container
A container is like a drawer, with 3 parts
One for video
One for audio
One for metadata
Generic containers
Quicktime (Apple)
.mov
Windows video container
.avi
Specific containers
Video
Containers only for MPEG2 Codec, only picture (no sound)
.mpv
.m2v
Containers only for MP4 (H264) Codec
.mp4
It can be very poor quality, or excellent quality
Containers for MPEG1 video and MPEG2 video
.mpg
Container only for specific MP4 Codec made by Macromedia for video on the web
.flv
Container for the phone videos in the beginning
.3gp
Container for Windows Media Video
.wmv
Open source video Codec and container
.ogv
Only for AVCHD Codec
.mts
Universal container
.mxf
For WebM Codec videos
.webm
Audio
Audio for DVD
.mp2
Containers for audio without a Codec (uncompressed)
Windows
.wav
Mac
.aiff
.aif
Very old container
.sd2
.mp3
Container only for Dolby Digital audio Codec
.ac3
Open source audio Codec and container
.ogg