# TECHNICAL PRODUCTION 101


# FORMAT

- Technical but not difficult, 101 level discussion
- Open discussion, ask anything at any time (I may defer)
- General talk about digital video (15 minutes)
- Formatted around "Take Aways"
- I may adjust on the fly for time (this is usually a 4 or 6 week workshop)
- Open to suggestions and steering!
- Please ask about gear!
- Analog & tapes went the way of the dinosaur, we're talking modern workflows

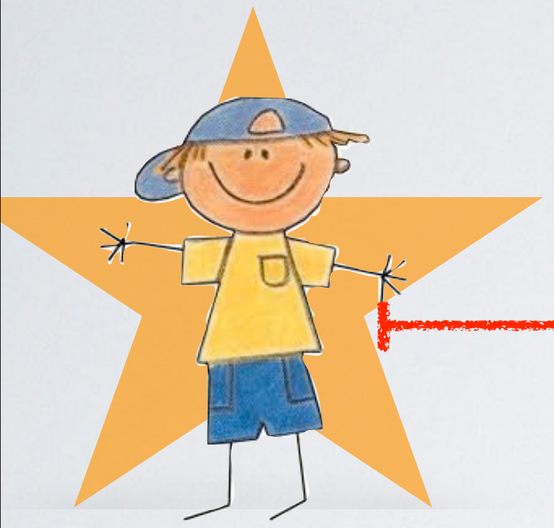

Take Away Alert

# STUFF TO LEARN IN WEEK 1

- Sampling: The difference between digital and analog
- RAW and Uncompressed Video: What is it?
- Chroma Sampling and Color Depth: Why they are important
- Color Balance: An important production step
- Cables: Connecting my stuff

# TYPICAL COMMON WORKFLOW

Getting video from point A to B



**Real World:**
**People**
**Places**
**Things**

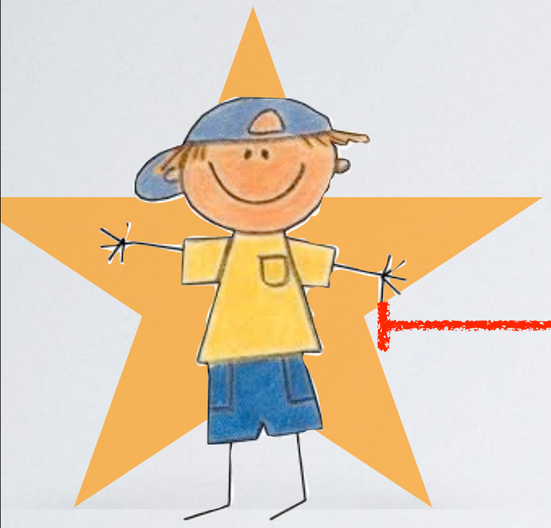
**File Camera:**
**MP4/h.264**
**ProRes/DNxHD**
**XDCAM**
**AVCHD**
**XAVC**

**Editor:**
**Avid (DNxHD)**
**Final Cut (ProRes)**
**Premiere (Native)**

**Deliverables:**
**Digital Master**
**Broadcast**
**Contribution**
**Social Media**
**Web Host**
**DVD / BluRay**

# ACADEMIC WORKFLOW

Getting video from point A to B



**Real World**

**Camera / Capture / Digitizer**

**Edit / Post**

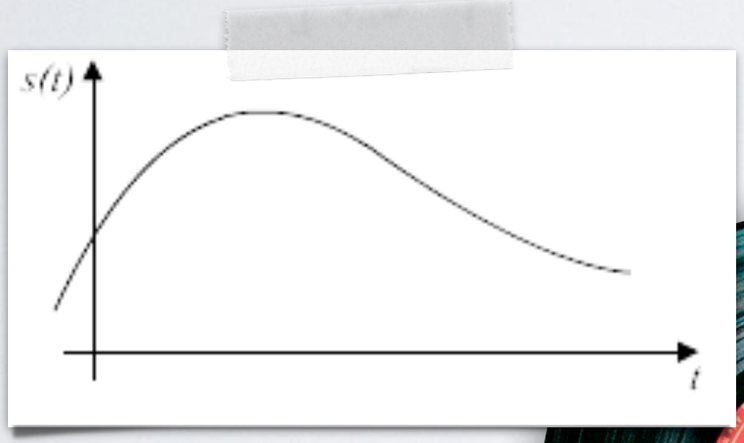
**Compression and Deliverables**

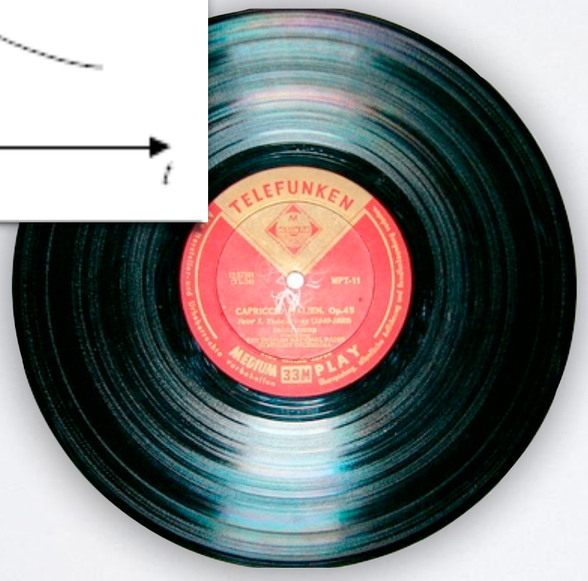
# DIGITAL SAMPLING

Take Away Alert

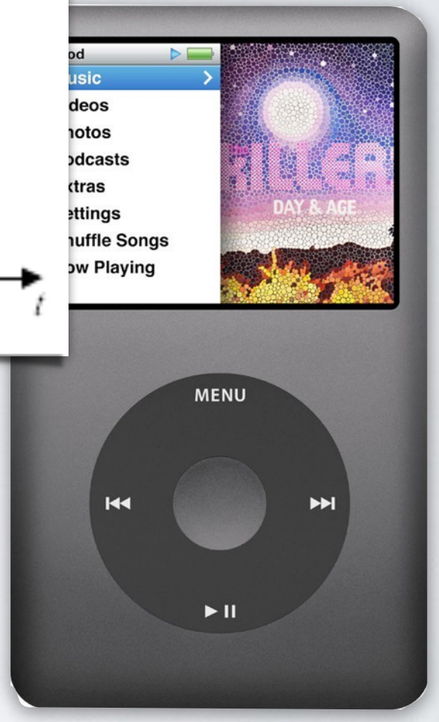
The whole concept of all things digital

Records vs MP3 players are the best example



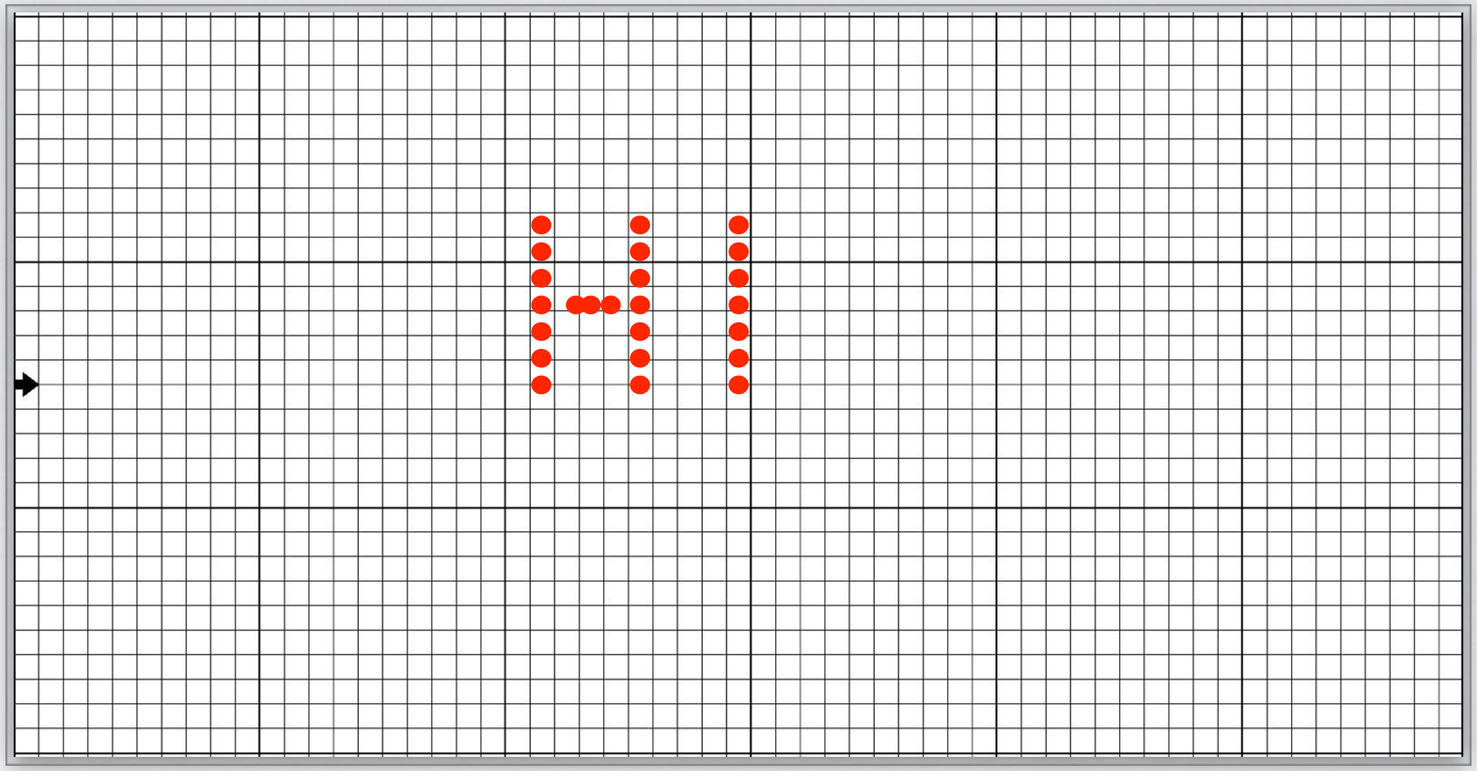







# WHAT IS VIDEO?

(in technical terms and keeping sampling in mind)



# WHAT IS VIDEO?

(in technical terms and keeping sampling in mind)

Digital video is a method of representing a moving picture, we do this by "sampling" the analog world.

Everything in the video world is based on the concept of breaking down our analog world into bits. We represent space with pixels. We represent time with frames (or fields).

Every image you see is effectively a Monet painting, every video you see is basically a child's flip book.

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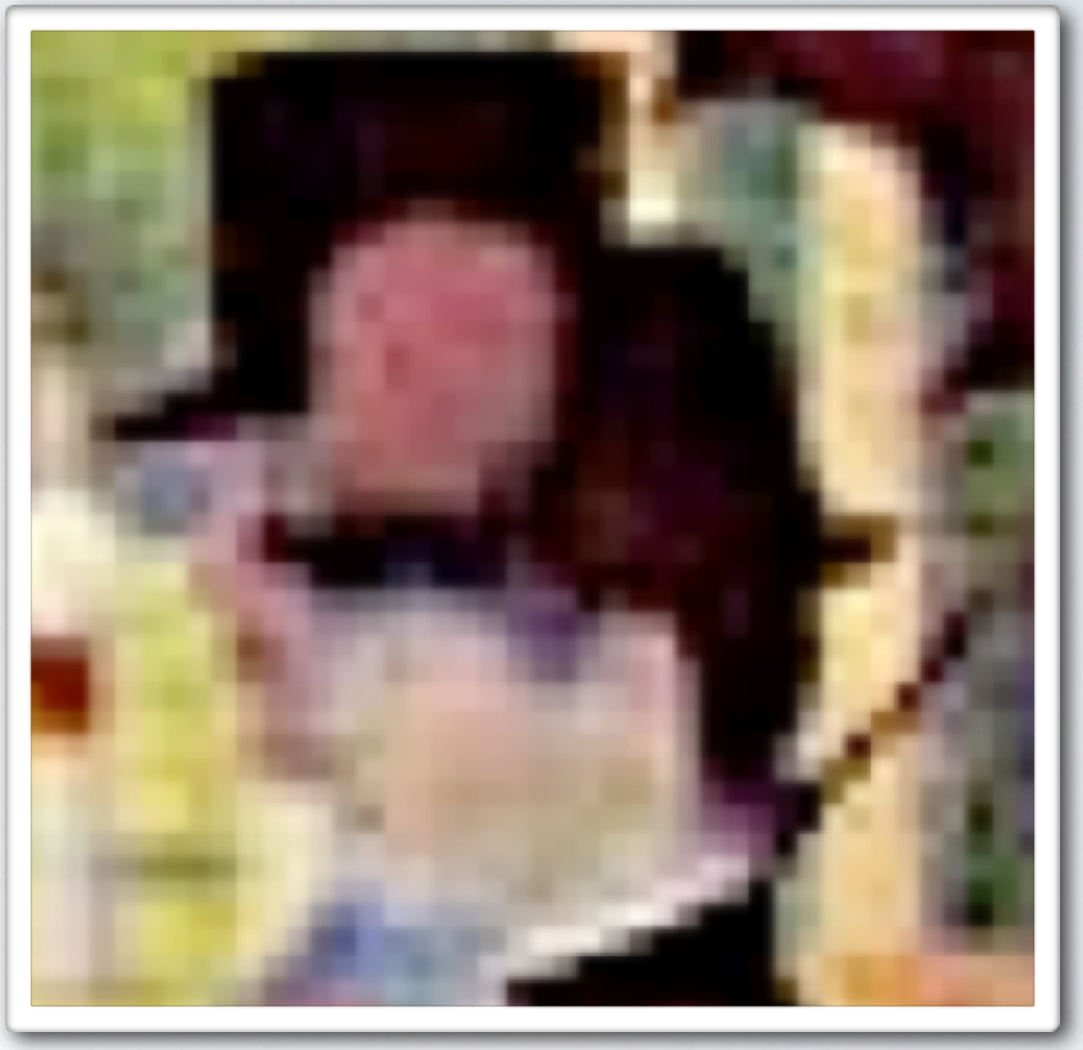
# PIXELS

Just a bunch of little dots

Just a bunch of little dots

We measure pixel color by counting from 0 to 255 in three different categories for green, red and blue. 0 is black, 255 is white. 1 through 254 is a shade of light, the higher the brighter.

Numbers must be integers.



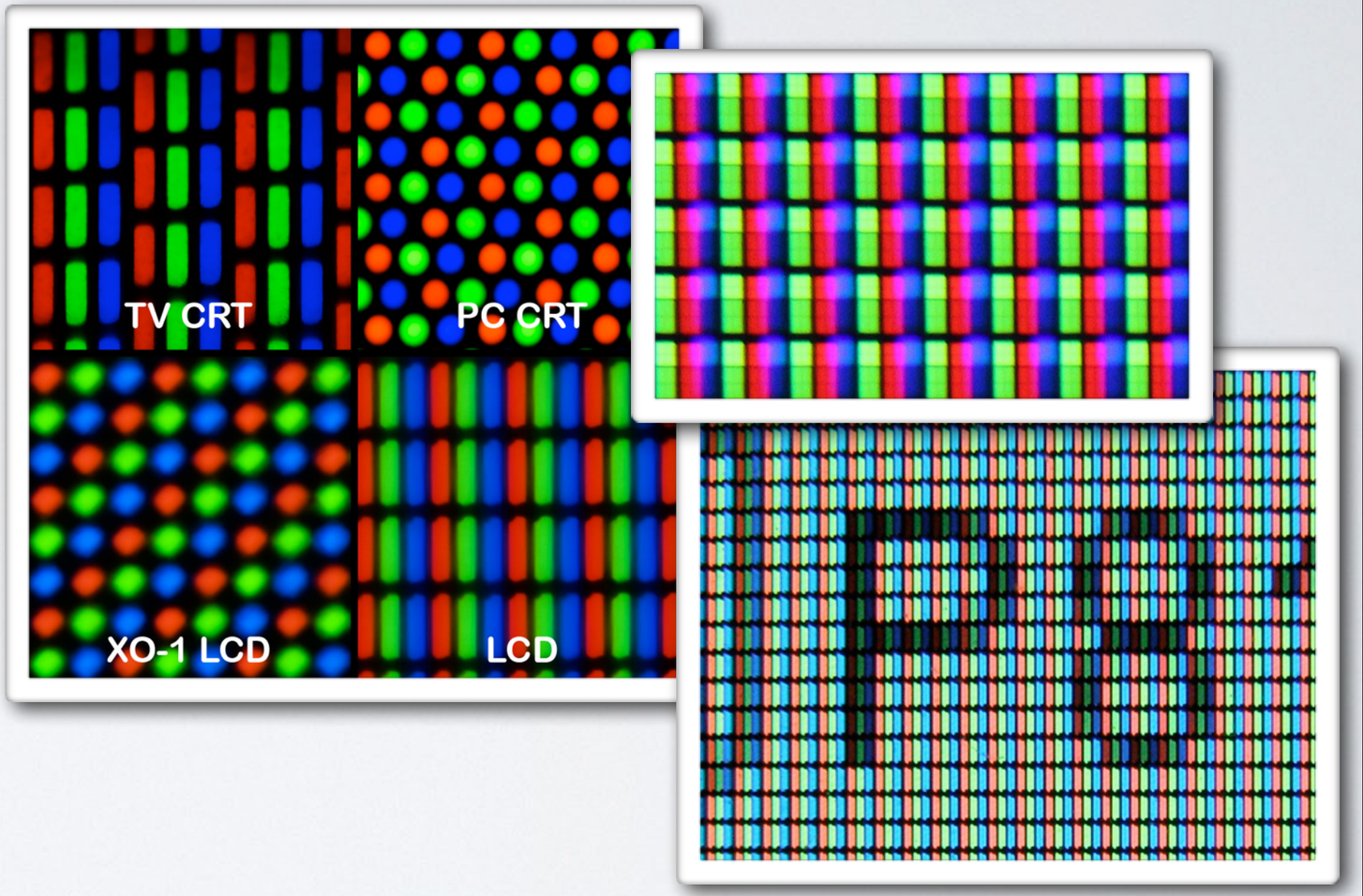
# MAKEUP OF A PIXEL

A pixel isn't a pixel, it's comprised of sub-pixels

The pixels on a or sensor monitor do not measure or turn red, green or blue.

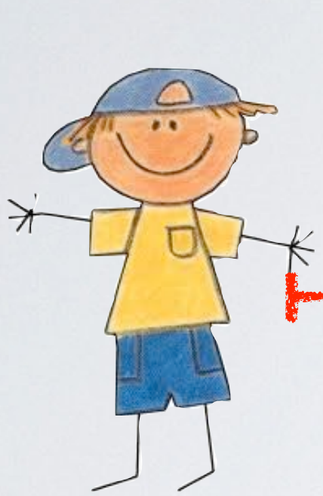
Instead, each pixel is comprised of sub-pixels. There are three sub-pixels for each real pixel placed very close to each other

BTW, that black space between the pixels is called "dot pitch"



# WORKFLOW

Getting video from point A to B



Real World

Camera / Capture / Digitizer

Editor

Compression and Deliverables

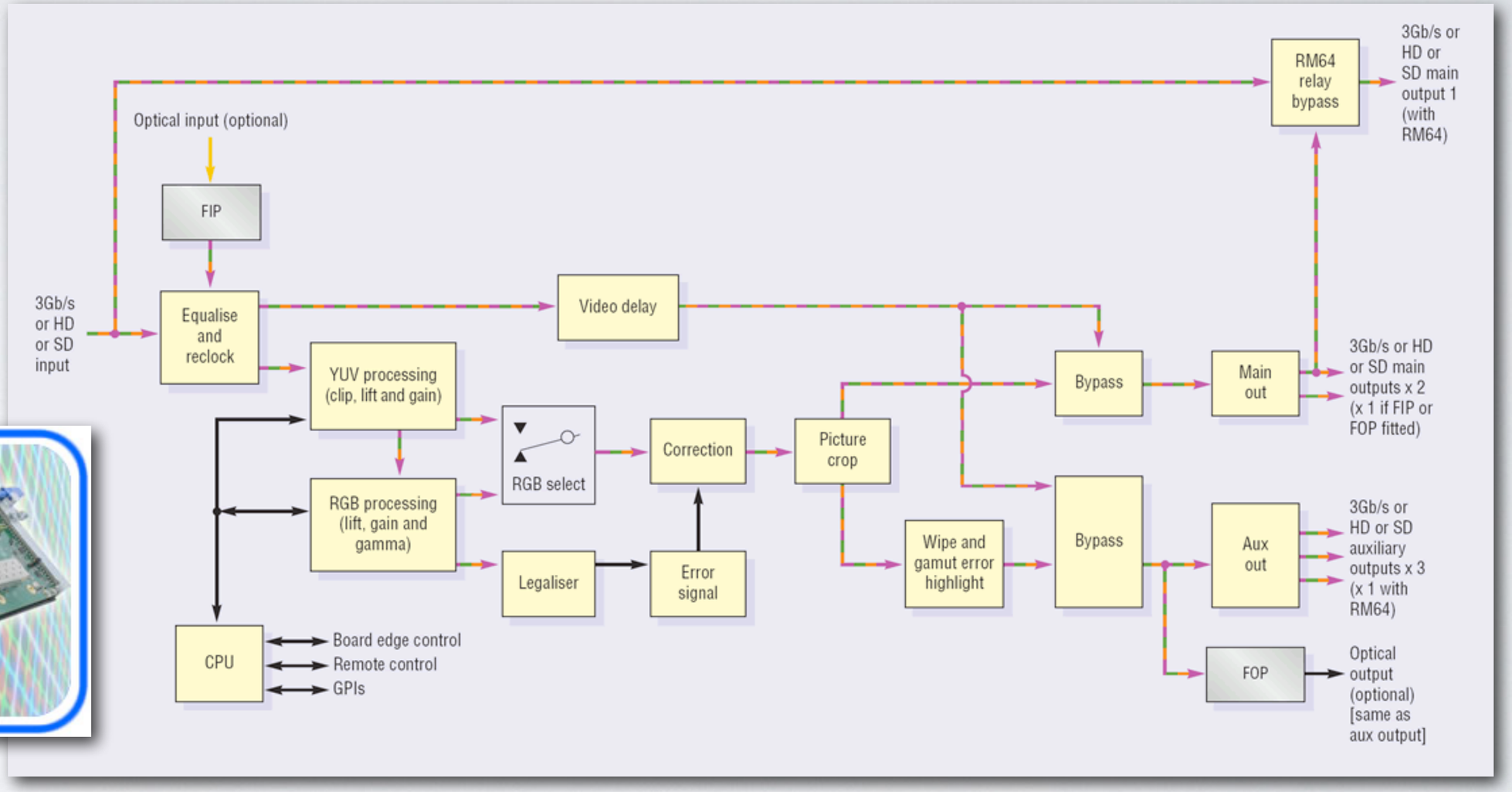


# BLOCK DIAGRAMS

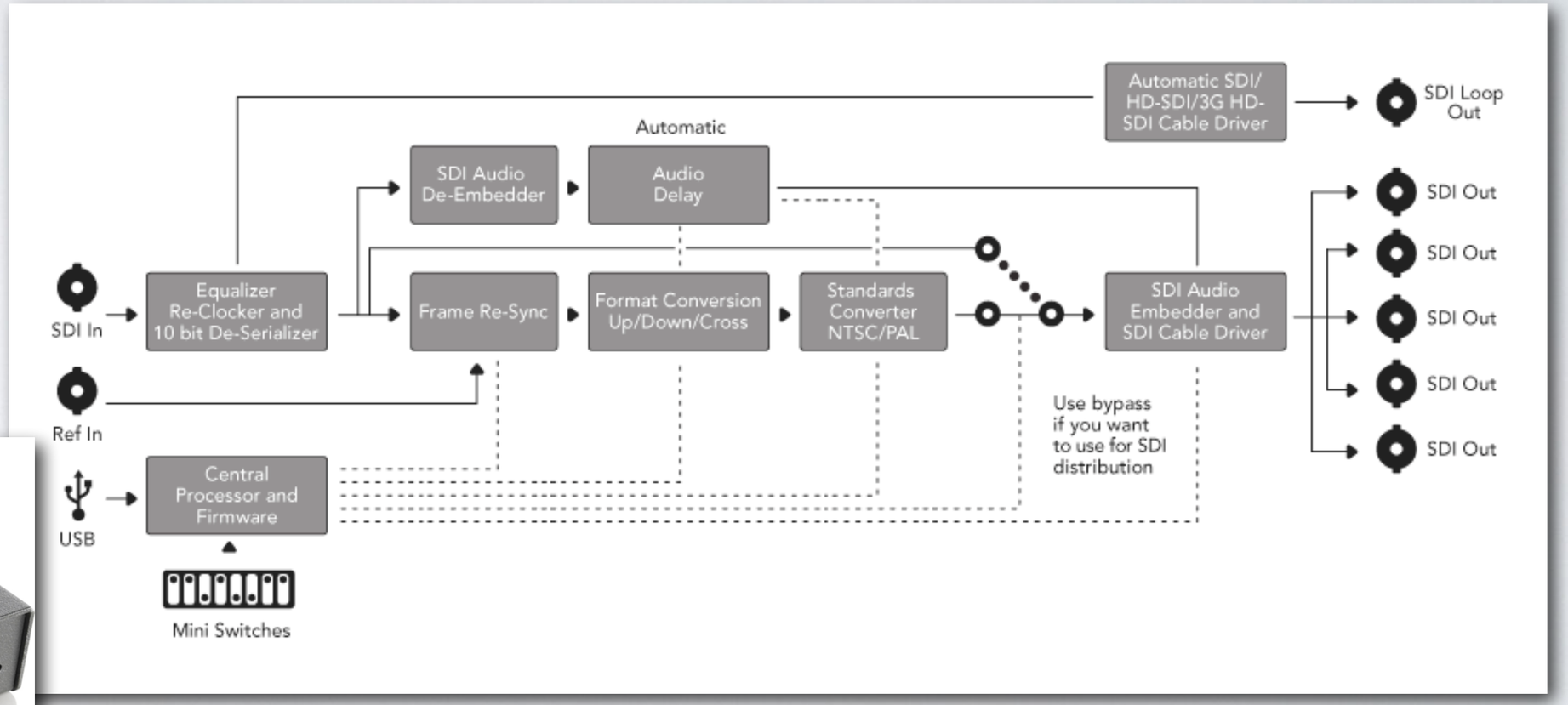
All electronic devices have various subsystems. How these subsystems interact and how data flows from various internal components can make a big difference to how a technical system functions.

Technicians will often make block diagrams to better understand how to configure a components.

# BLOCK DIAGRAMS

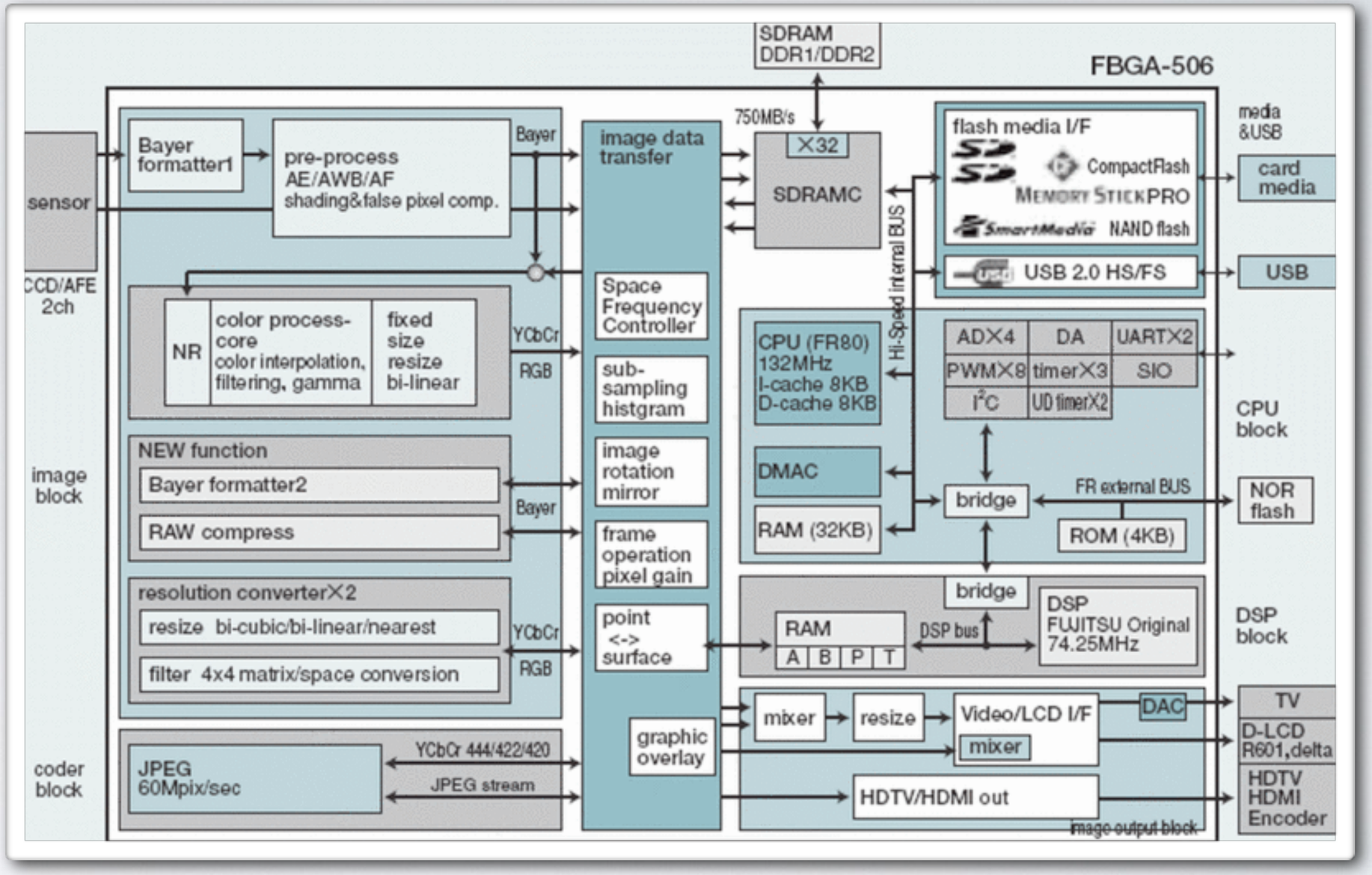


# BLOCK DIAGRAMS

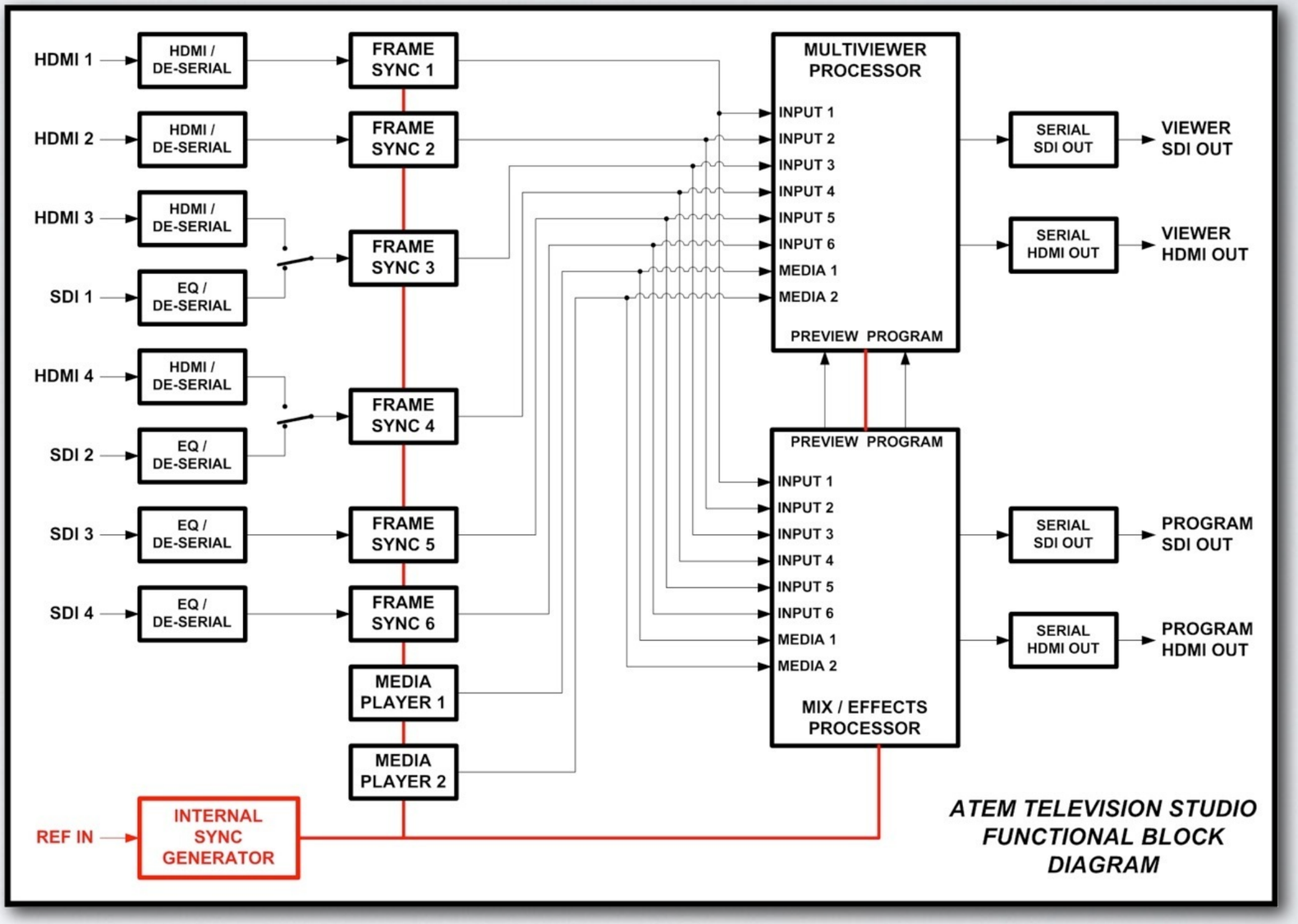
# BLOCK DIAGRAMS


Example: Fujitsu Milbeaut



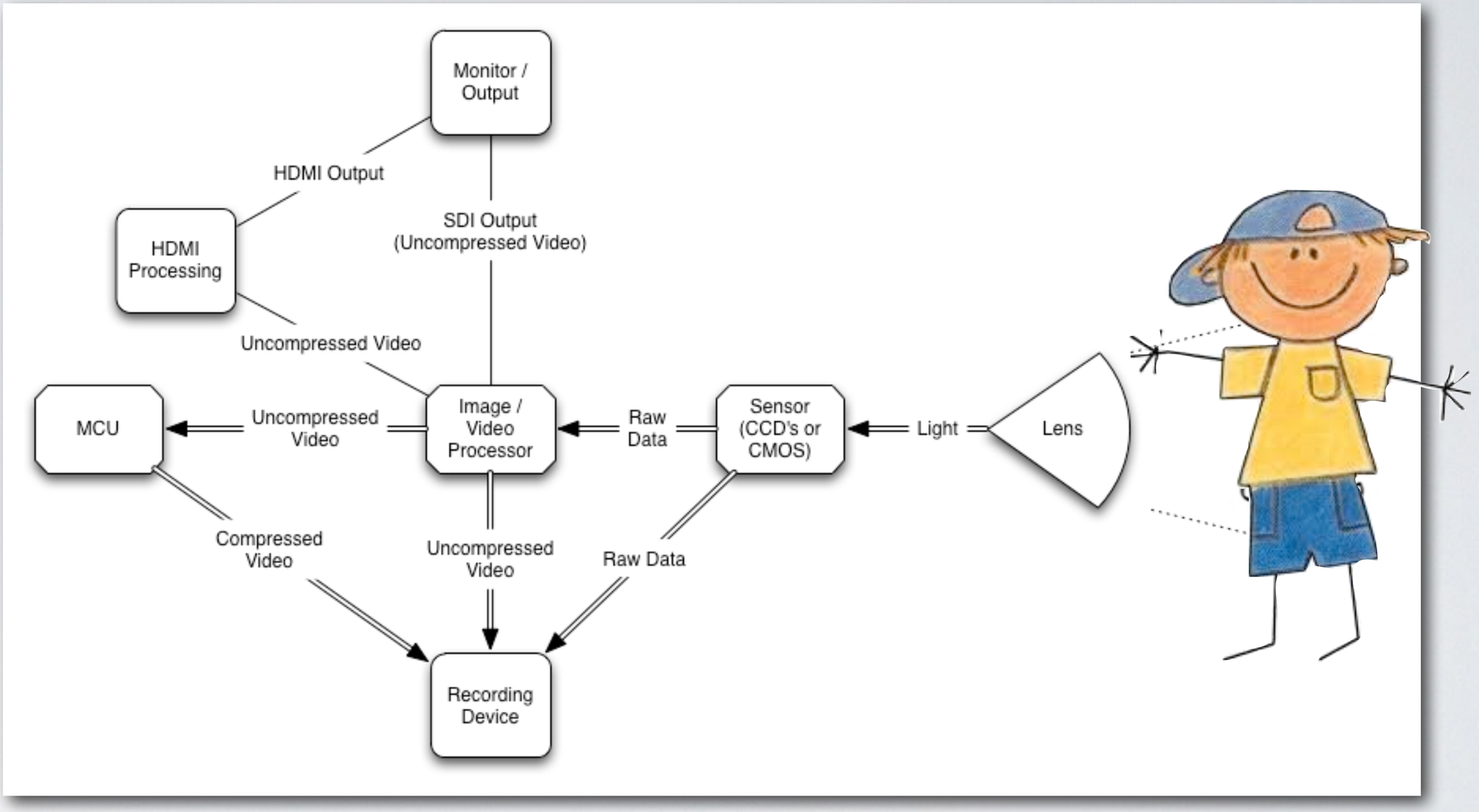
# BLOCK DIAGRAMS


Example: Blackmagic ATEM Television Studio Switcher



Example: A camera I made up in my head

# BLOCK DIAGRAMS



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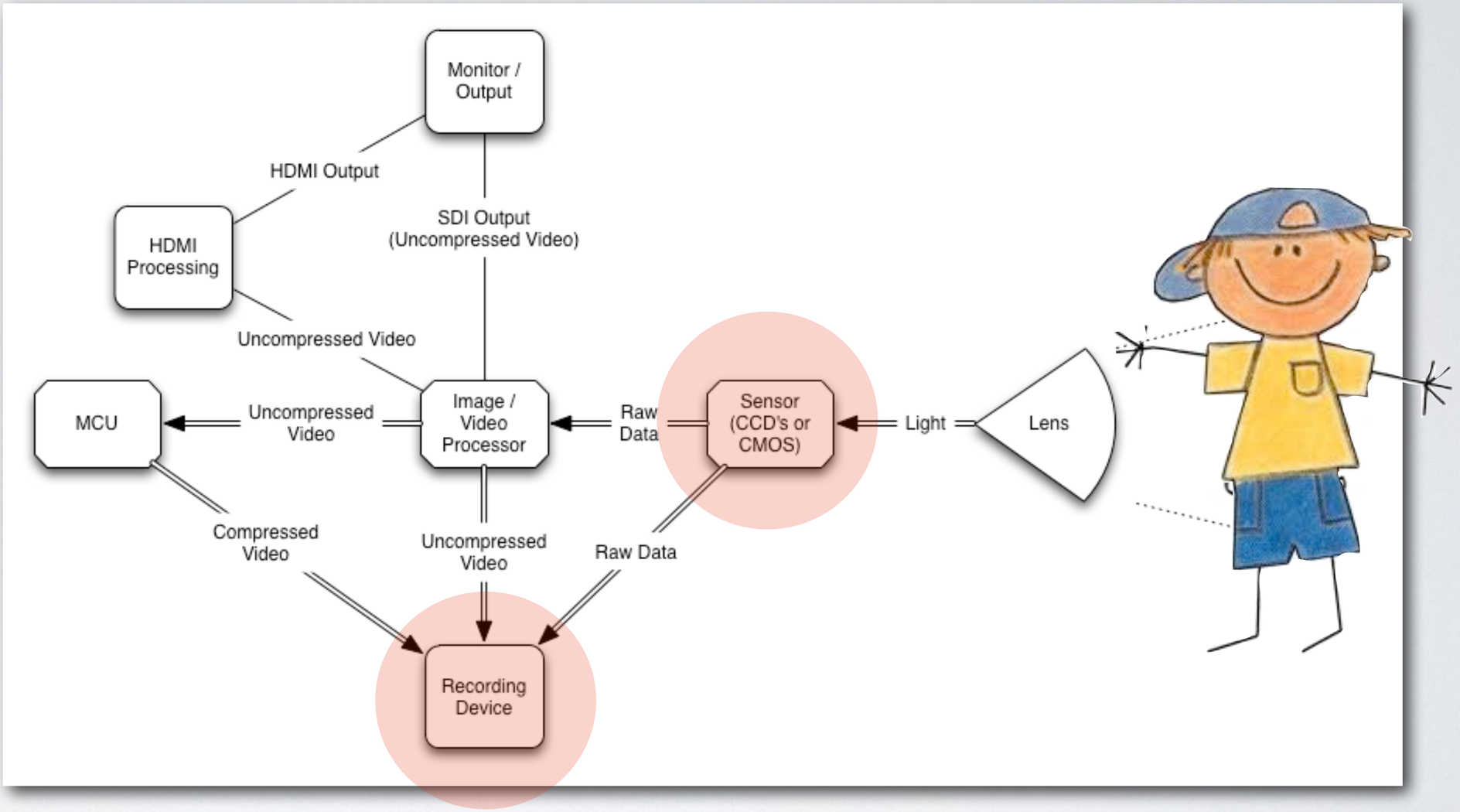


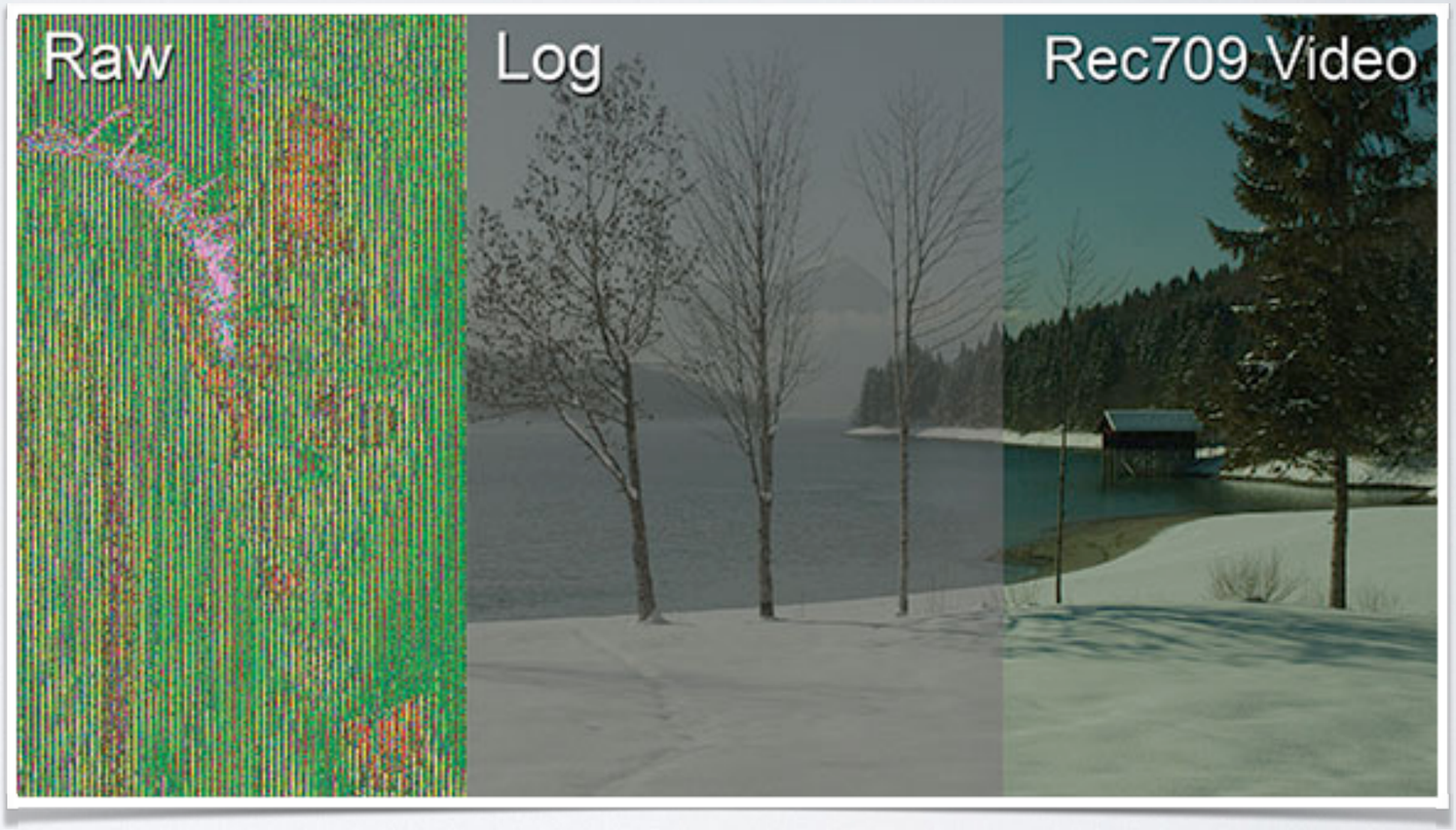
# RAW

Raw, Uncompressed, and Log video explained

Raw video isn't actually video, in fact it's just a pure data dump from the camera's sensor.

You cannot see raw sensor data on a monitor.

It can only be seen on a computer with special software that first processes it into an image.

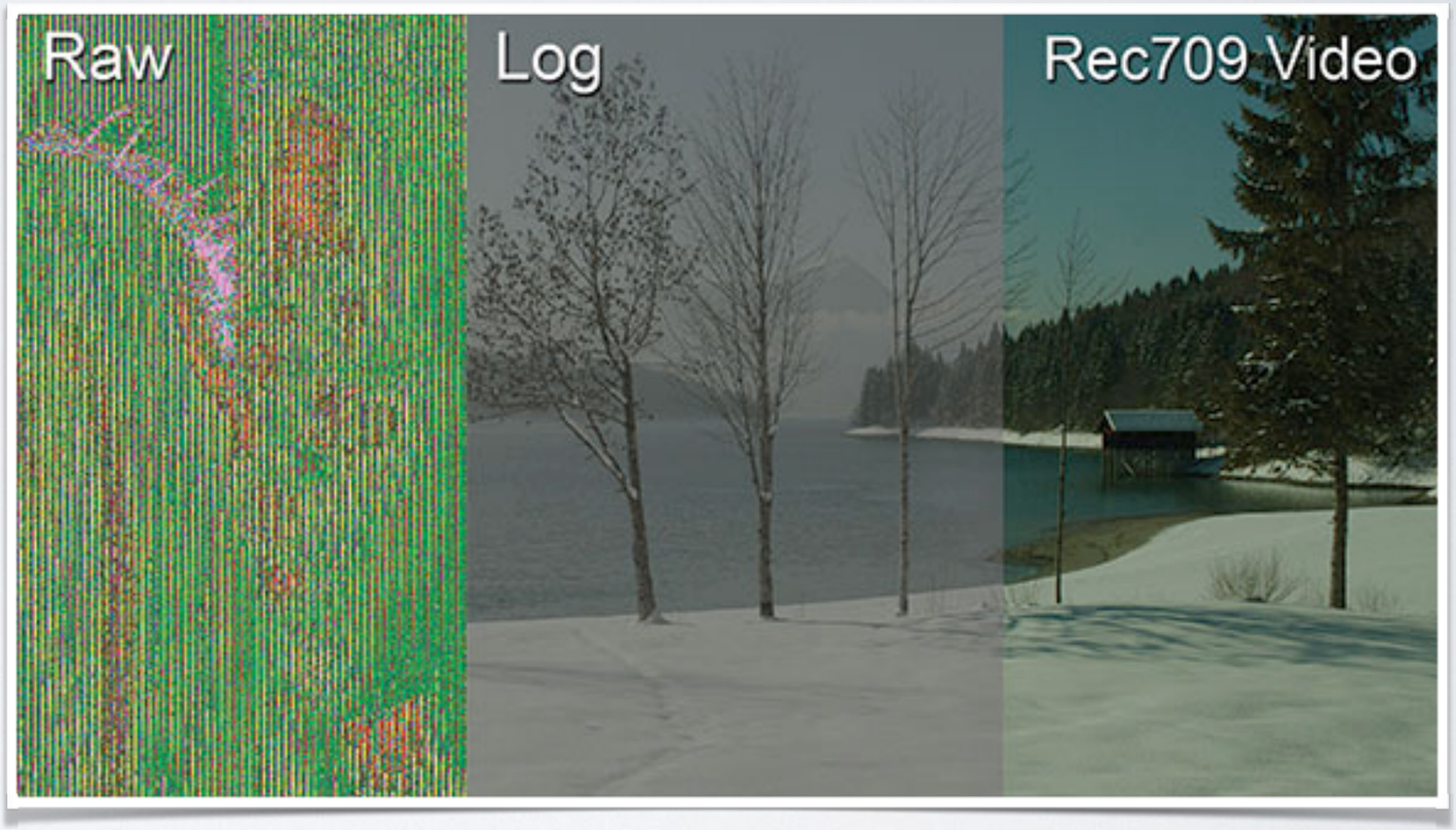


# RAW

Raw, Uncompressed, and Log video explained

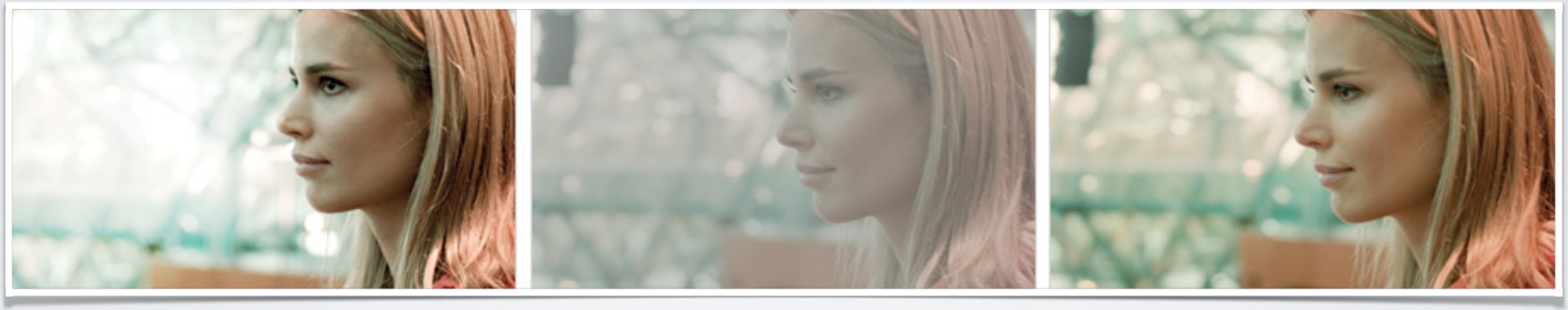
Pros:
Full dynamic range of the sensor is captured
No information is lost

Cons:
Very difficult to work with
Not portable to other devices
Very slow workflows



# RAW

Raw, Uncompressed, and Log video explained



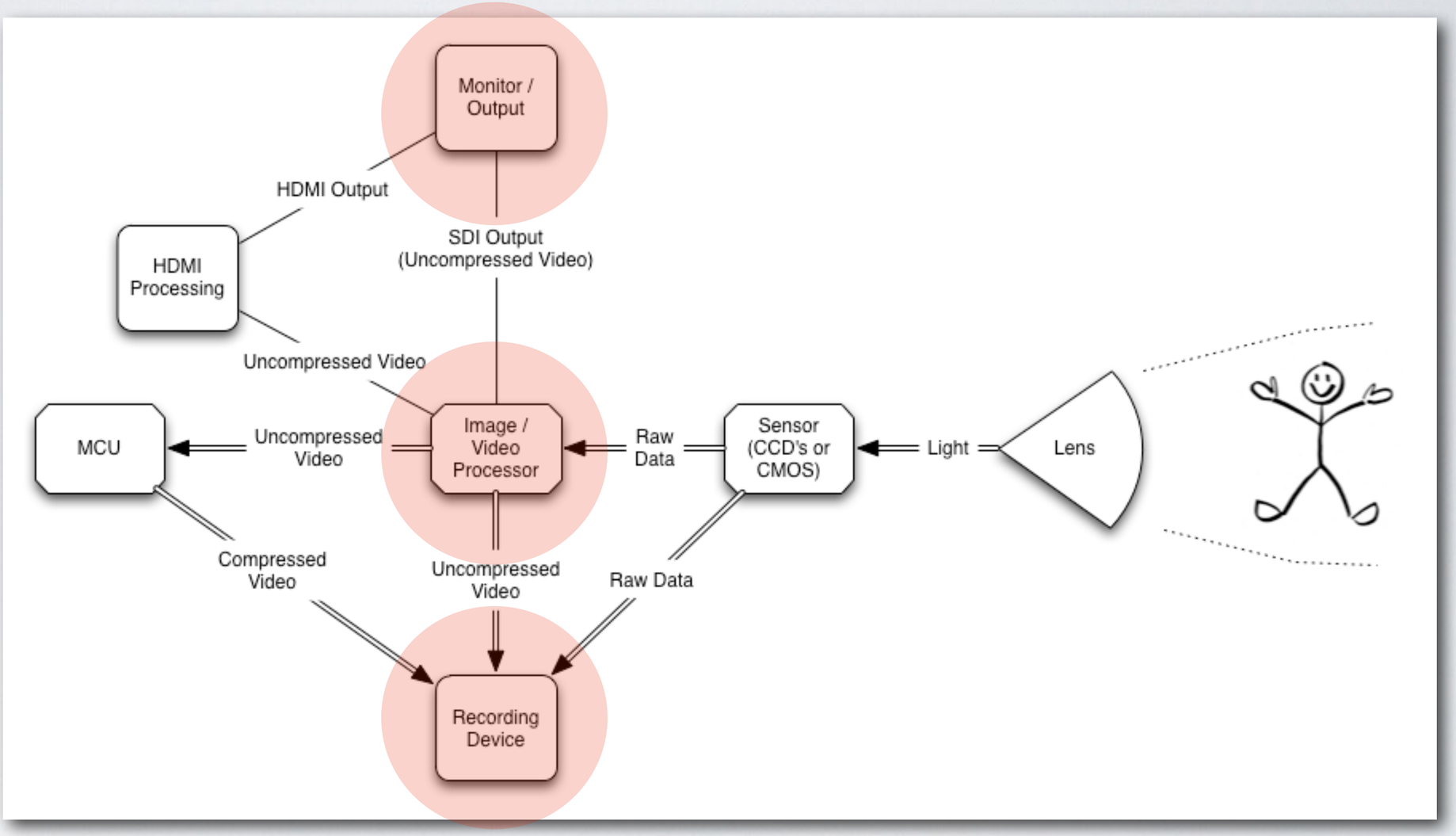
Regular h.264 Camera Rig

RAW Unprocessed

Processed RAW Video

# BLOCK DIAGRAMS

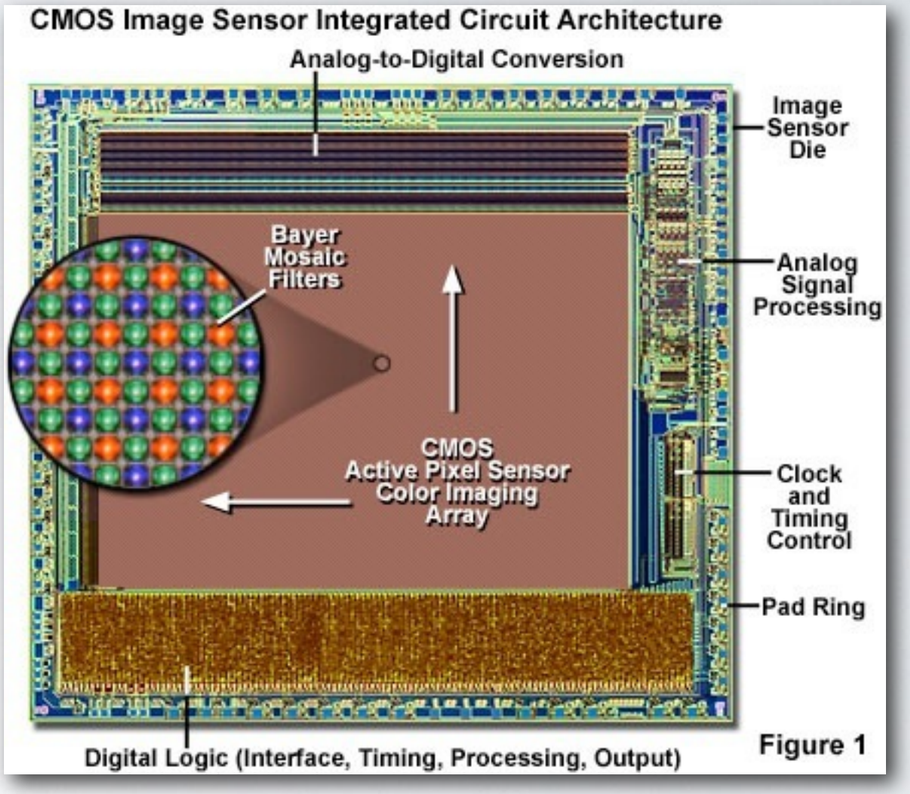
Example: A camera I made up in my head

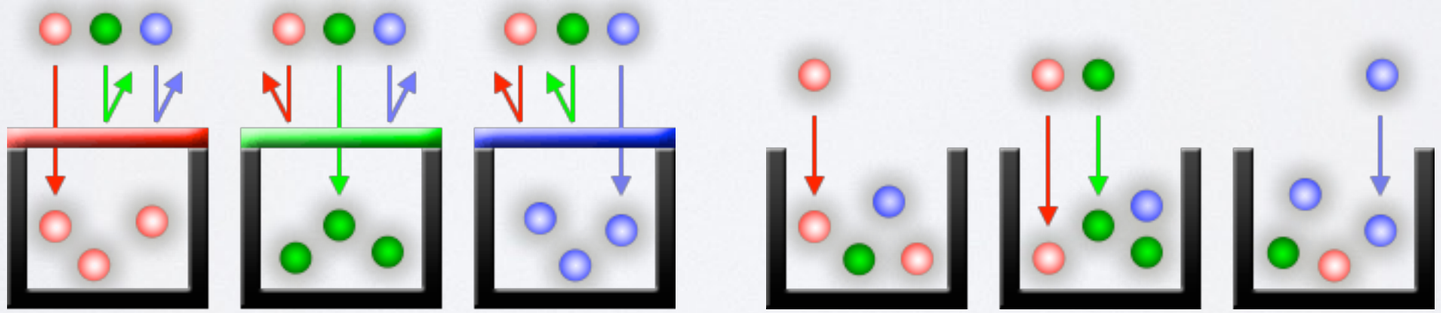


# SENSORS

Sensors on chips are composed of "photosites". Each photo site captures red, green or blue. There are three photosites per pixel.

Photosites and are color blind!



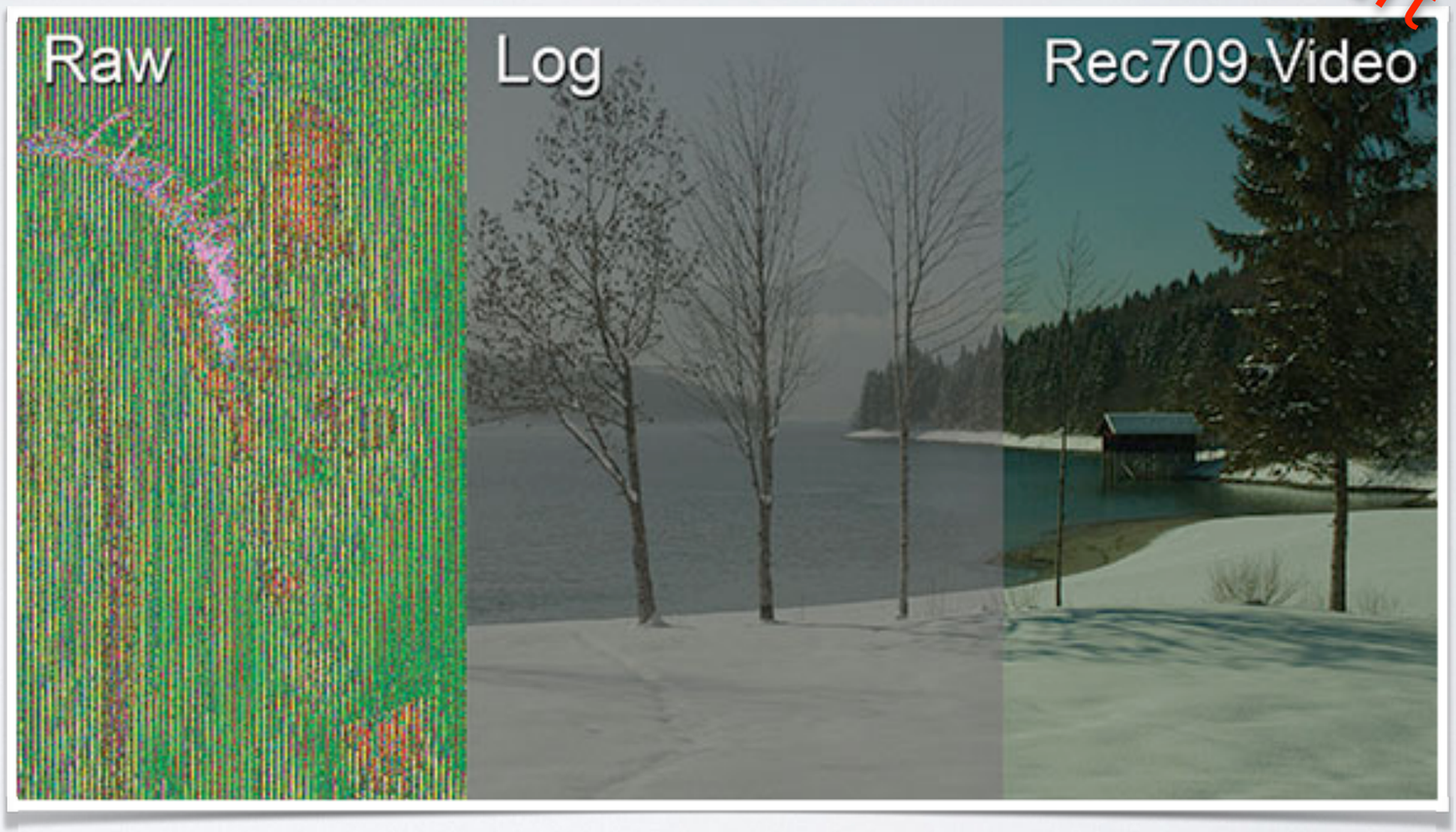
# UNCOMPRESSED

Take Away Alert

Raw, Uncompressed, and Log video explained

Uncompressed video is actually video.

Data from the camera's sensor goes through the cameras image processor where it is sampled and conformed to video standards (usually rec709 for HD cameras)



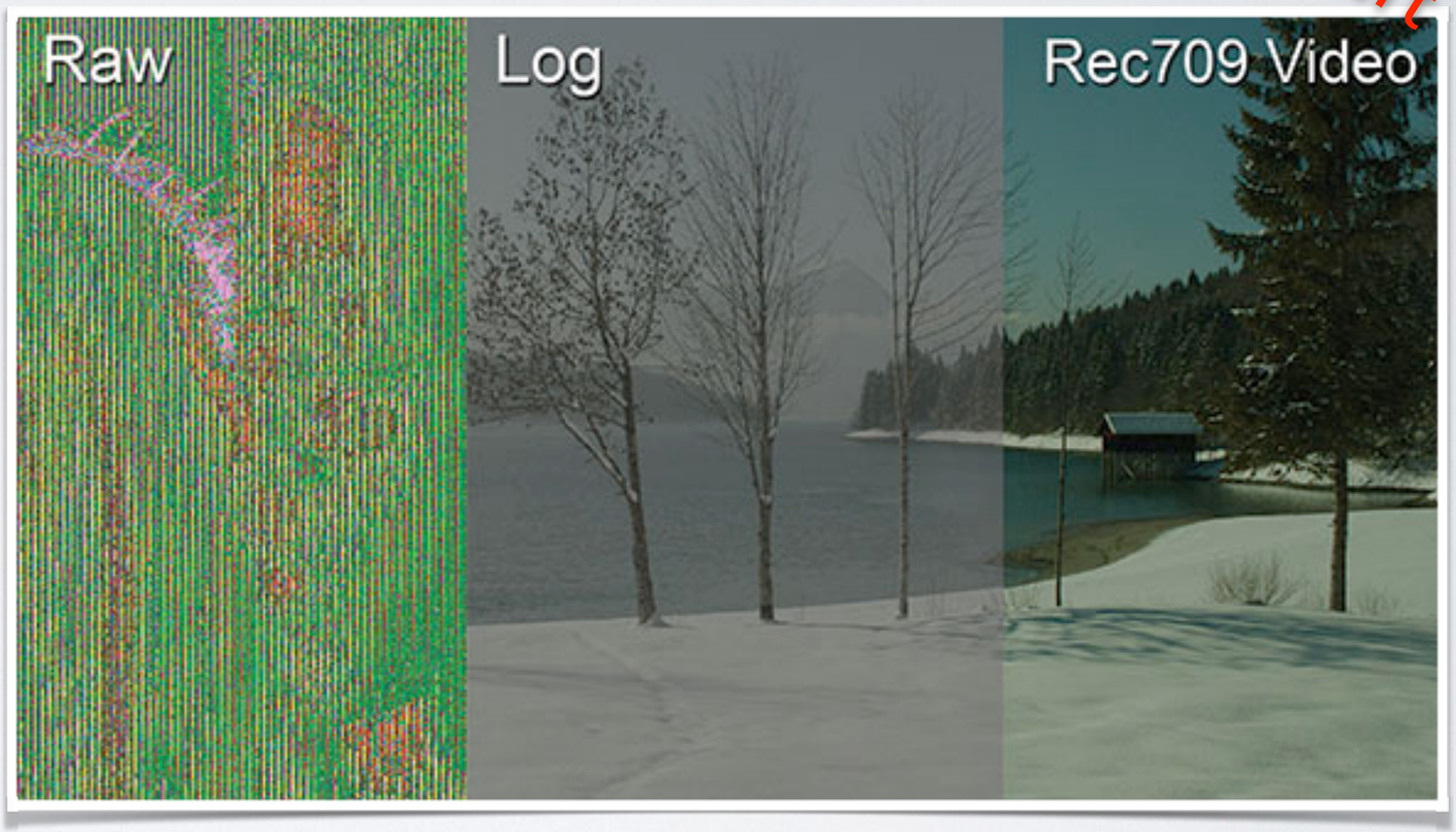
# UNCOMPRESSED

Take Away Alert

Raw, Uncompressed, and Log video explained

Pros:
Much faster workflow
Can be monitored
Compatible and portable to other devices

Cons:
Information outside of the video sample is permanently lost.



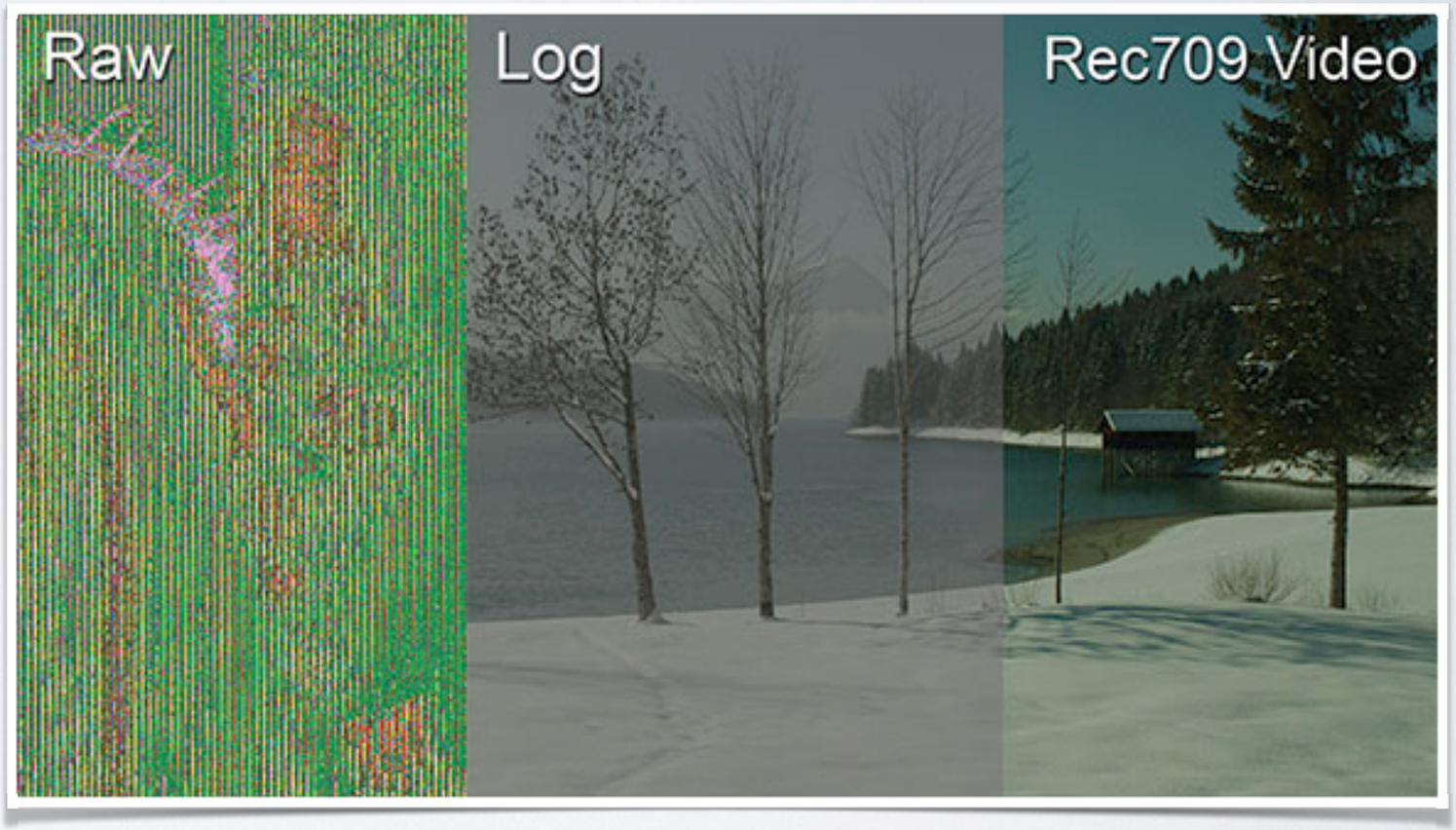
# LOG

Raw, Uncompressed, and Log video explained

Log is a mode that is somewhere in between Raw and uncompressed video.

More of the sensor data is captured than uncompressed video but less than raw.

Can be monitored or connected to other devices like video.



# COLOR DEPTH

Take Away Alert

2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2

All colors on sensor photo-sites are rated on a scale of 0 - some number. There are three categories, red, green and blue. Values must be integers!

In 8-bit video, shades are graded on a scale of 0-255 (256 colors). There are 16.777 million color possibilities in this scheme.

In 10-bit video, shades are graded on a scale 0-1024 for each color for a total of 1.07 BILLION color possibilities

# COLOR DEPTH

2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2

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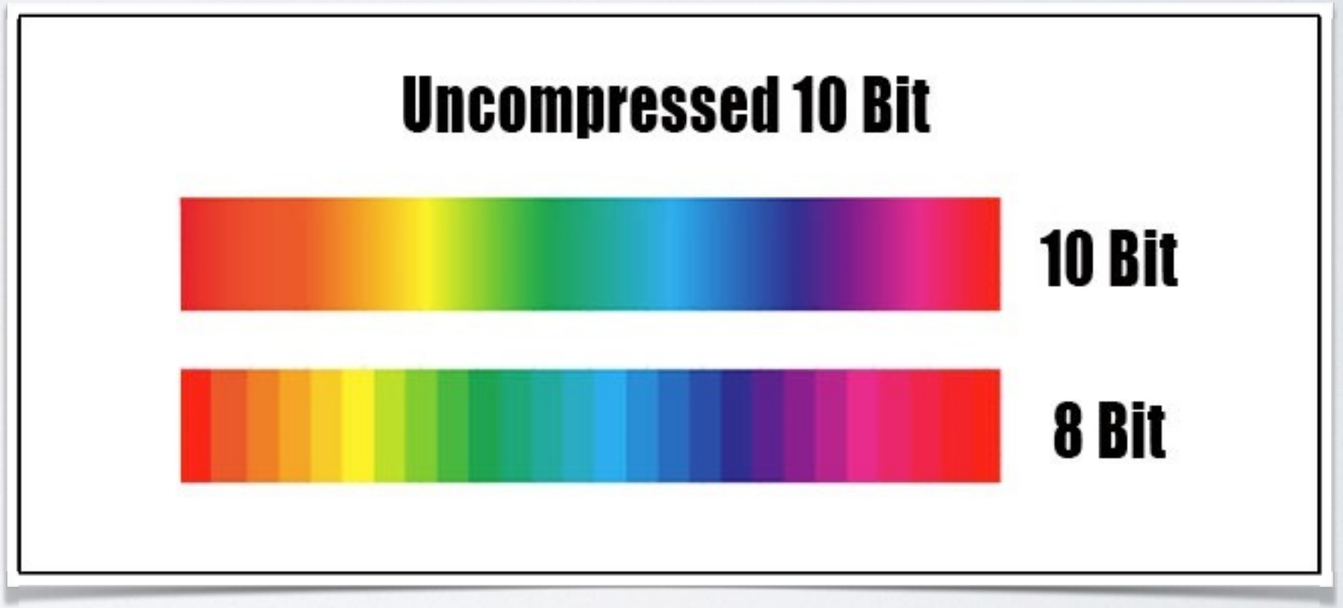
In 10-bit video, shades are graded on a scale 0-1023 for each color for a total of 1.07 BILLION color possibilities



# COLOR DEPTH

2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2

*8-bit video*

*10-bit video*

# CHROMA SAMPLING

Take Away Alert

When turning sensor data into video, we must sample it. Green is always sampled 100% of the time, red and blue are sample at

4:4:4 - RGB - Uncompressed Video (not subsampled)

4:4:4 - YCbCr - Uncompressed Video, this scheme is used to approximate RGB

4:2:2 - YCbCr - Uncompressed Video. Red and blue are sampled 2 times for every 4 times green is sampled. Very popular in higher end recording devices. Uses 1/3rd less bandwidth but is visually indistinguishable to 4:4:4 in most cases.

4:2:1 - Forget this one, no one uses it

4:1:1 - Red and blue are sample 25% as often as green. Very Popular in DV cameras

4:2:0 - Red and blue are sampled 50% less than green/luminance but only every other line. Very popular, used extensively in broadcast and DVD.

# CHROMA SAMPLING

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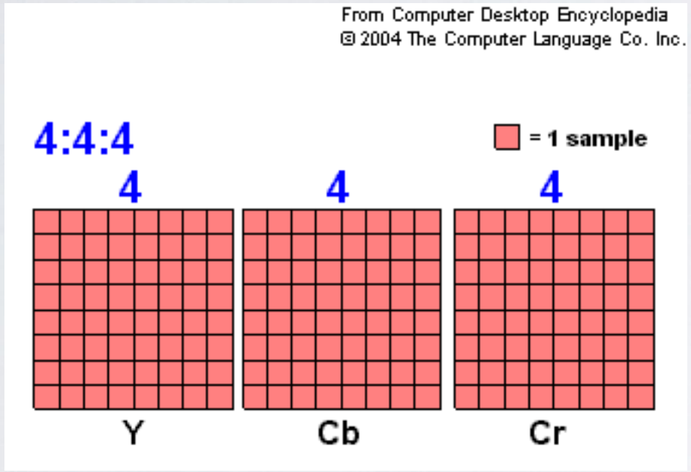


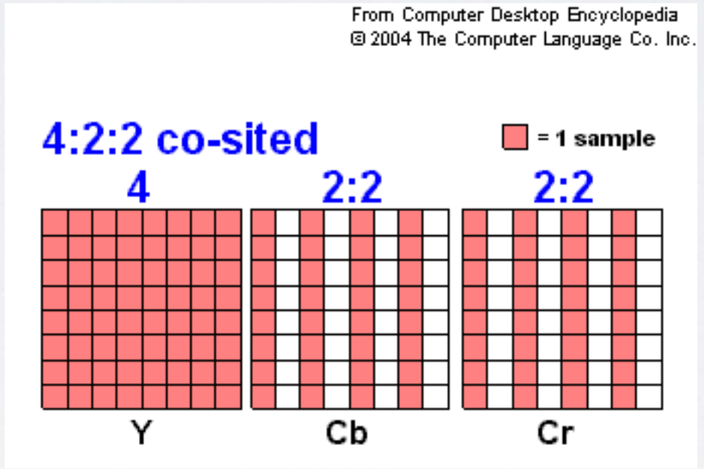


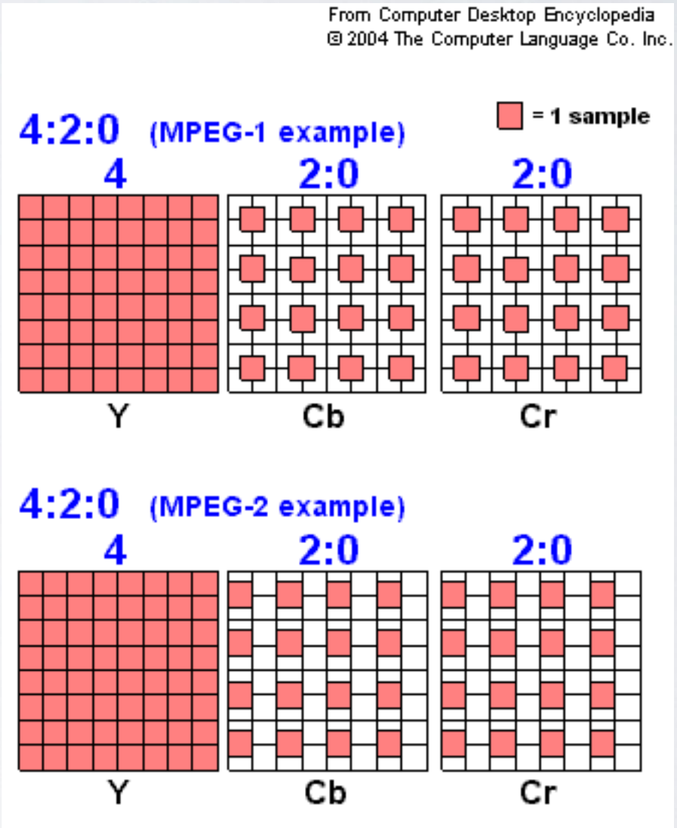


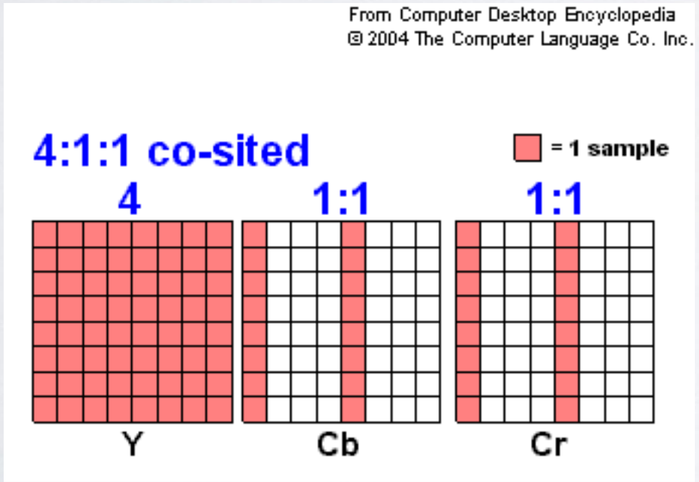

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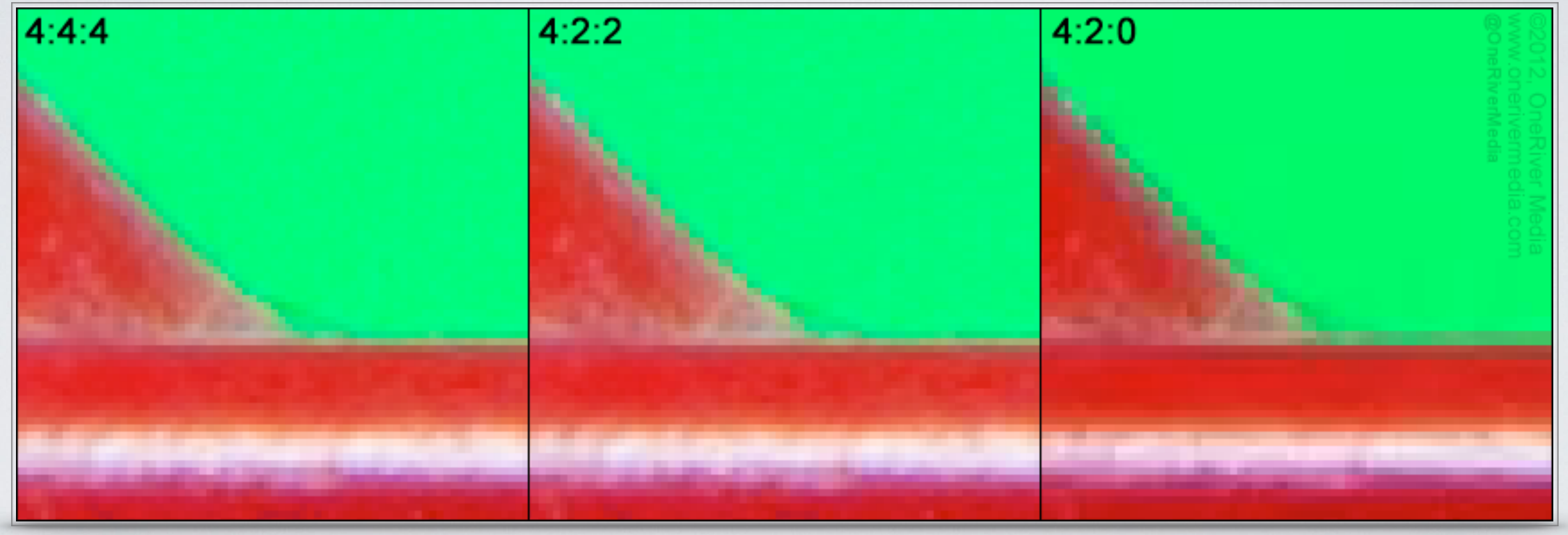
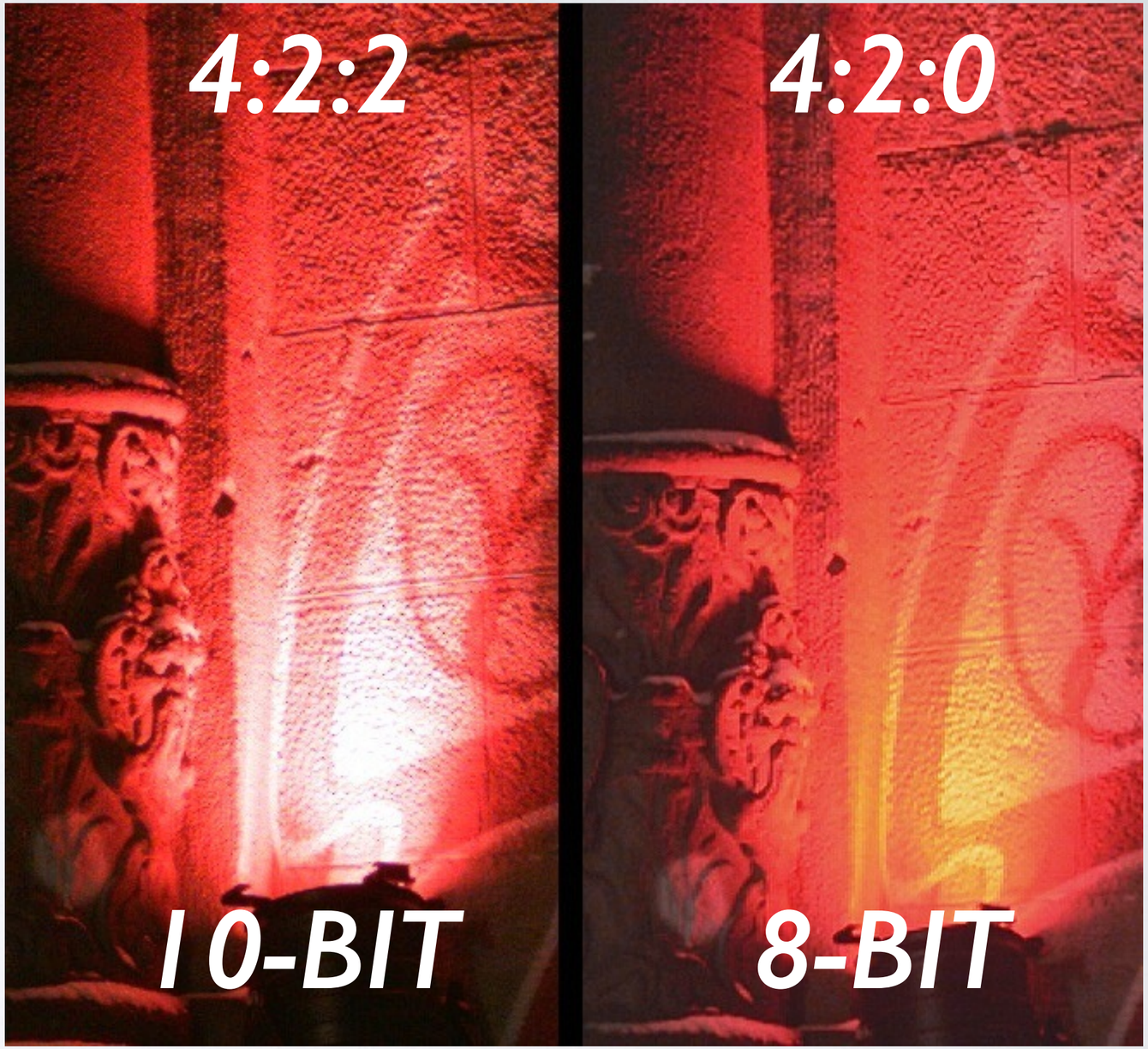


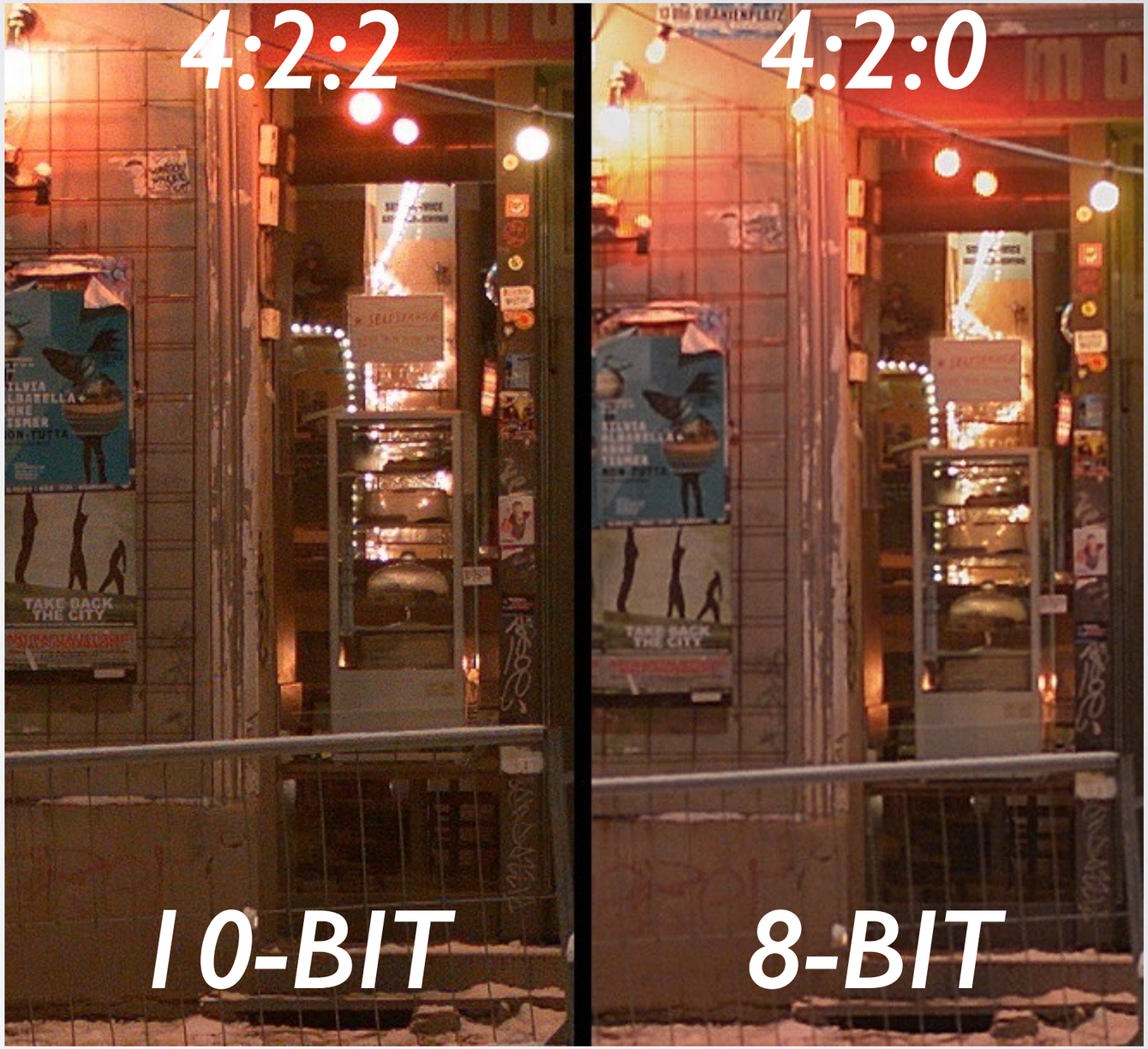
# SO WHAT?

COLOR DEPTH &
CHROMA SAMPLING:

WHY THEY ARE IMPORTANT



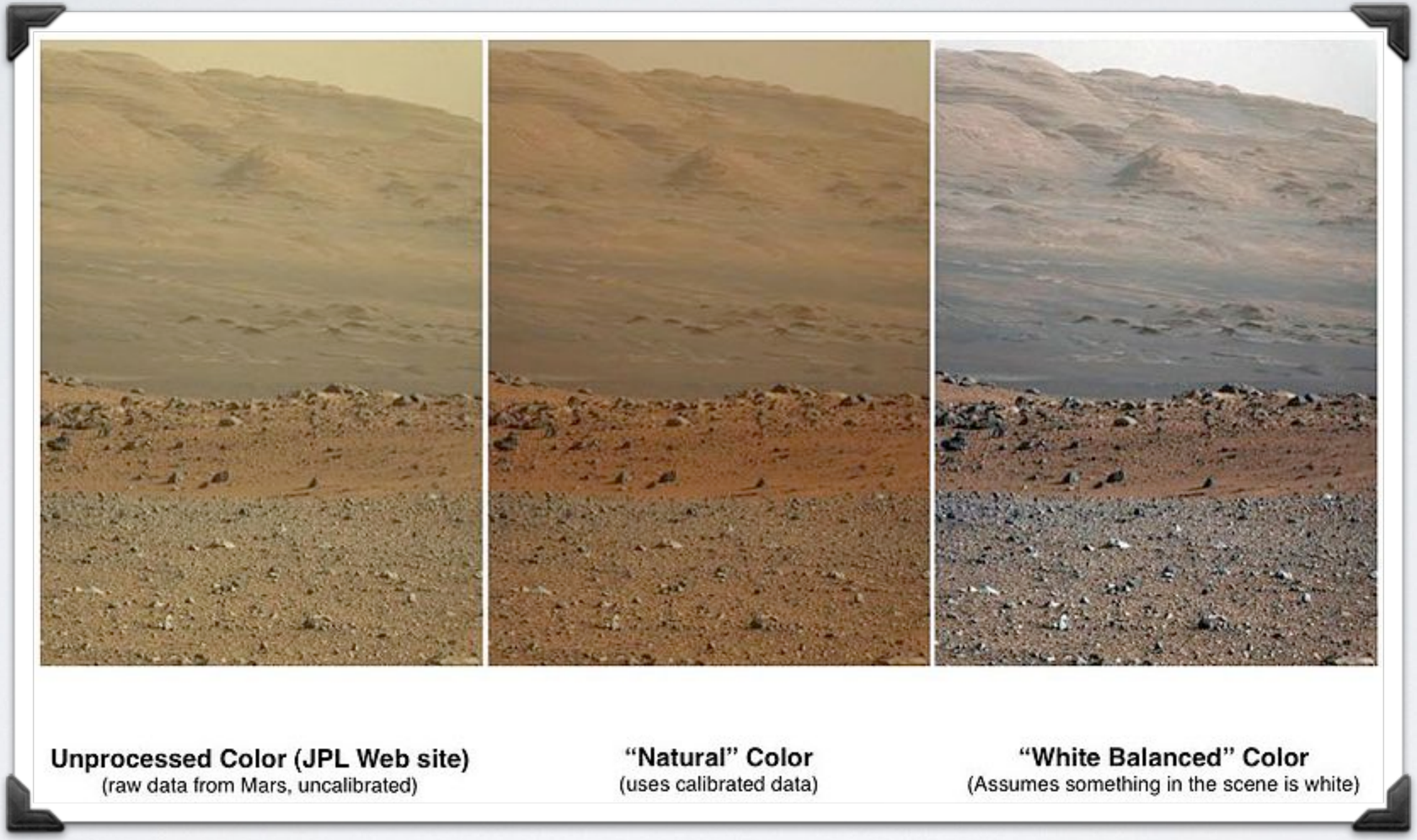
# COLOR DEPTH & CHROMA SAMPLING



Ki Pro:  Can records at up to10-bit 4:4:4 (depending on model)
Sony HDC-X310's:  Output 10-bit, 4:4:4 HD-SDI
JVC GY-HM700's:  8-bit 4:2:0
Blackmagic Cinema Camera:  Records at up to 12-bit raw, 10-bit uncompressed
HDV:  Records at 4:2:0, 8-Bit
MiniDV / DVCAM / DVCPro:  Records at 4:1:1, 8-Bit
Cinedeck:  Records at 4:4:4, 10-Bit
Gemini:  Records at 4:4:4, 10-Bit
Canon C300:  Records at 4:2:0, 8-Bit
Canon C100:  Records at 4:2:0, 8-Bit
Canon 5D:  Records at 4:2:0, 8-Bit
Atomos:  Records at 4:2:2, 10-Bit
nanoFlash:  Records at 4:2:2, 8-Bit
Digibeta:  Records at 4:2:2, 8-bit
HDCAM SR: Can record up to 4:4:4, 10-bit (usually used as 4:2:2 8-bit)
D-5: Records 4:4:4 10-bit
DVCPRO HD:  Records 4:2:2 8-bit

# COLOR BALANCE

Take Away Alert



**Unprocessed Color (JPL Web site)**
(raw data from Mars, uncalibrated)

**"Natural" Color**
(uses calibrated data)

**"White Balanced" Color**
(Assumes something in the scene is white)

FROM NASA

# COLOR BALANCE

## *AS EASY AS 1-2-3*

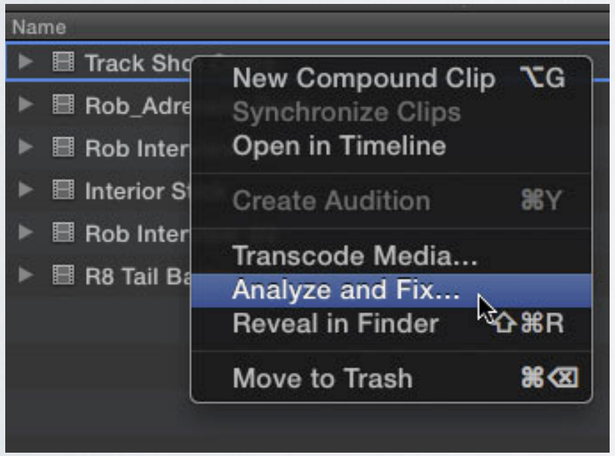
$$\begin{bmatrix} L_R \\ L_G \\ L_B \end{bmatrix} = \mathbf{P}^{-1} \begin{bmatrix} X_w/X'_w & 0 & 0 \\ 0 & Y_w/Y'_w & 0 \\ 0 & 0 & Z_w/Z'_w \end{bmatrix} \mathbf{P} \begin{bmatrix} L_{R'} \\ L_{G'} \\ L_{B'} \end{bmatrix}$$

$$\begin{bmatrix} L \\ M \\ S \end{bmatrix} = \begin{bmatrix} 1/L'_w & 0 & 0 \\ 0 & 1/M'_w & 0 \\ 0 & 0 & 1/S'_w \end{bmatrix} \begin{bmatrix} L' \\ M' \\ S' \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 255/R'_w & 0 & 0 \\ 0 & 255/G'_w & 0 \\ 0 & 0 & 255/B'_w \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix}$$

# COLOR BALANCE

## *JUST KIDDING*



# COLOR BALANCE

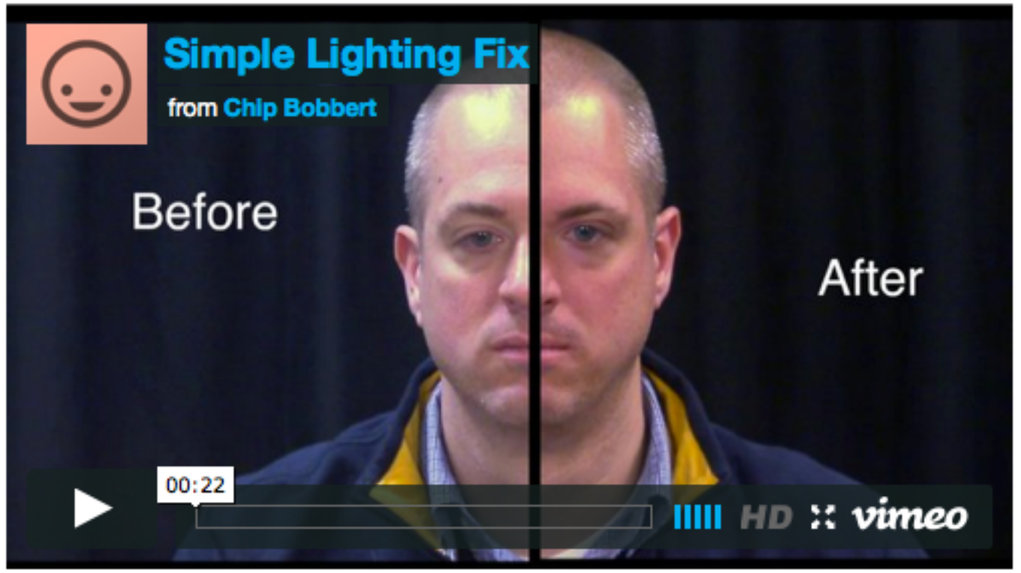
HOME

JW Player Pro Site License for Duke!

SONY Music Video Recorder

## Simple Lighting Tweaks For Video

*On February 5, 2014, in Classroom Technology, DDMC Info, Video Conferencing & TelePresence, Video Production, Web Conferencing, Webcam, by Chip Bobbert II*




In our MPS recording studio I set out to improve the lighting quality with a low budget. I thought I

# WORKFLOW

Getting video from point A to B

Real World

I

Camera / Capture / Digitizer

II

II.V

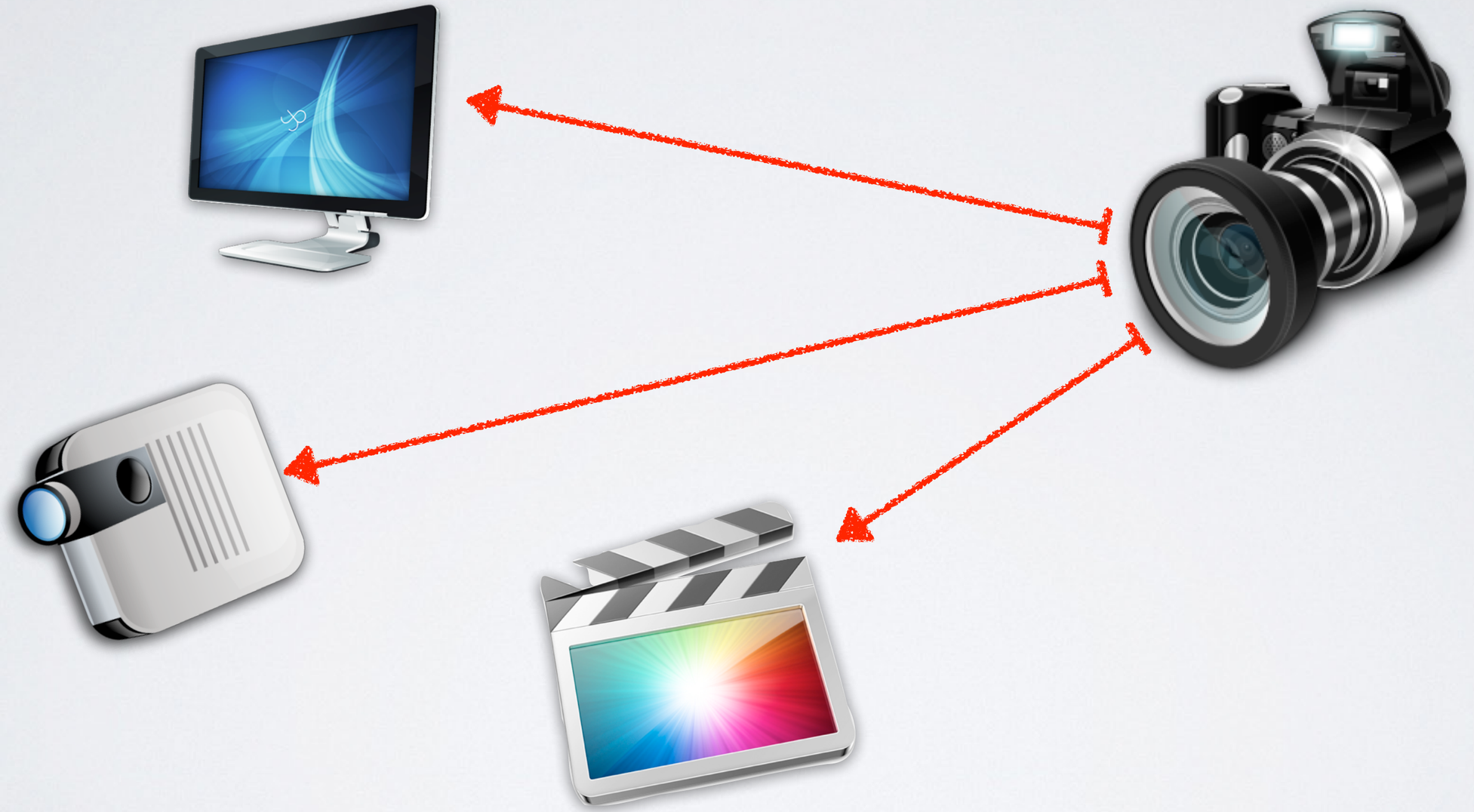
Recording / Editing

III

Deliverables

IV

# CONNECTIVITY

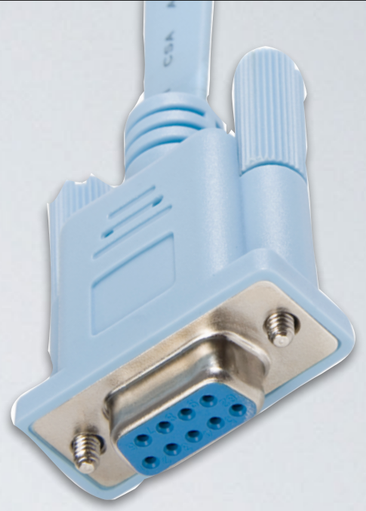


# PRACTICAL CONNECTIVITY

Take Away Alert

Fiber

RJ45



Serial

SDI

DisplayPort

HDMI

Thunderbolt

USB 2/3

FireWire
DVI
VGA
Analogs

# WORKFLOW

Getting video from point A to B

**Real World**

**Camera / Capture / Digitizer**

**Recording / Editing**

**Deliverables**

# PROBLEMS W/ UNCOMPRESSED

Take Away Alert

Very difficult to store and transmit. It consumes a tremendous amount of space and bandwidth.

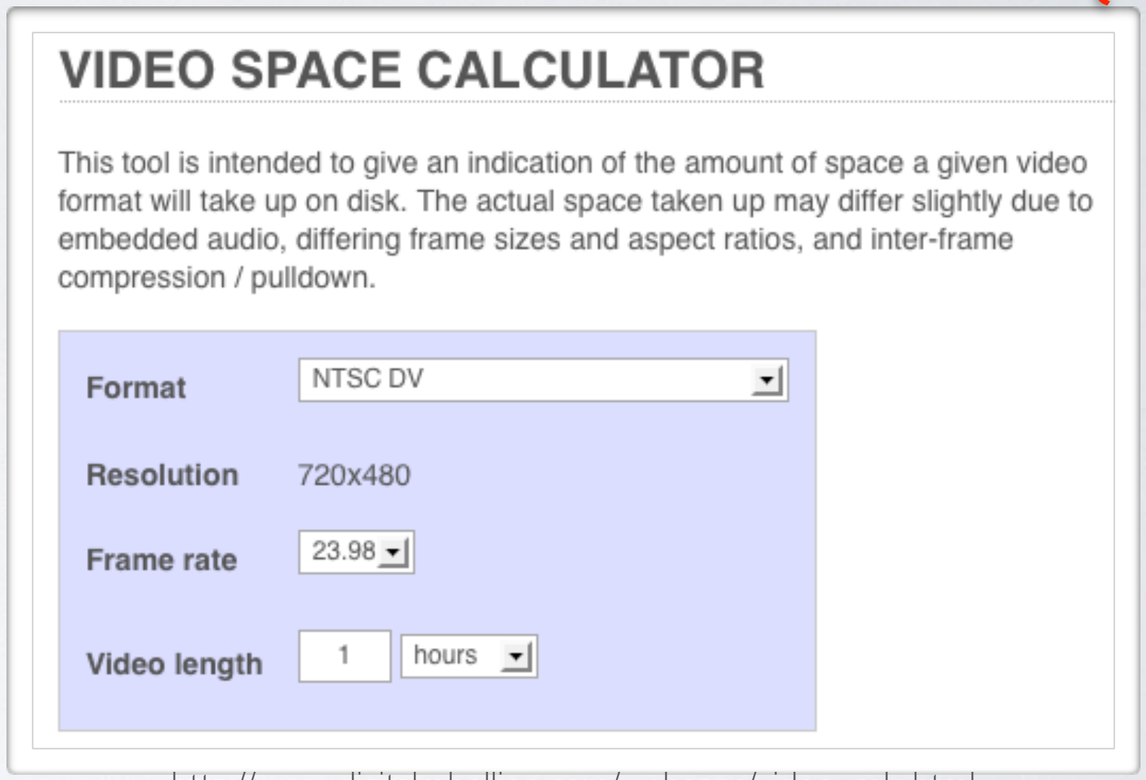
A single minute of uncompressed 1080 HD 10-bit video is 10-14 Gigabytes. A 30 minute program would consume most of a 500GB disk.

Uncompressed video requires about 1.4 Gb/s

Most computer drives supply less than 800Mb/s

The US television channels can only support 38 Mb/s

The average home broadband internet speed is 6.6Mb/s in the US




http://www.digitalrebellion.com/webapps/video_calc.html

# COMPRESSION

Video still needs to be compressed to work in practical situations.

This is done with a CODEC (**CO**mpressor **DEC**ompressor) CODECs provide the algorithms necessary to compress video at the point of origin and to decompress video at its destination so it is viewable.

Compressing video saves storage space and bandwidth on orders of magnitude.

# BALANCING THE SCALES

Paradox:

Producers want high quality, as close to uncompressed as they can get

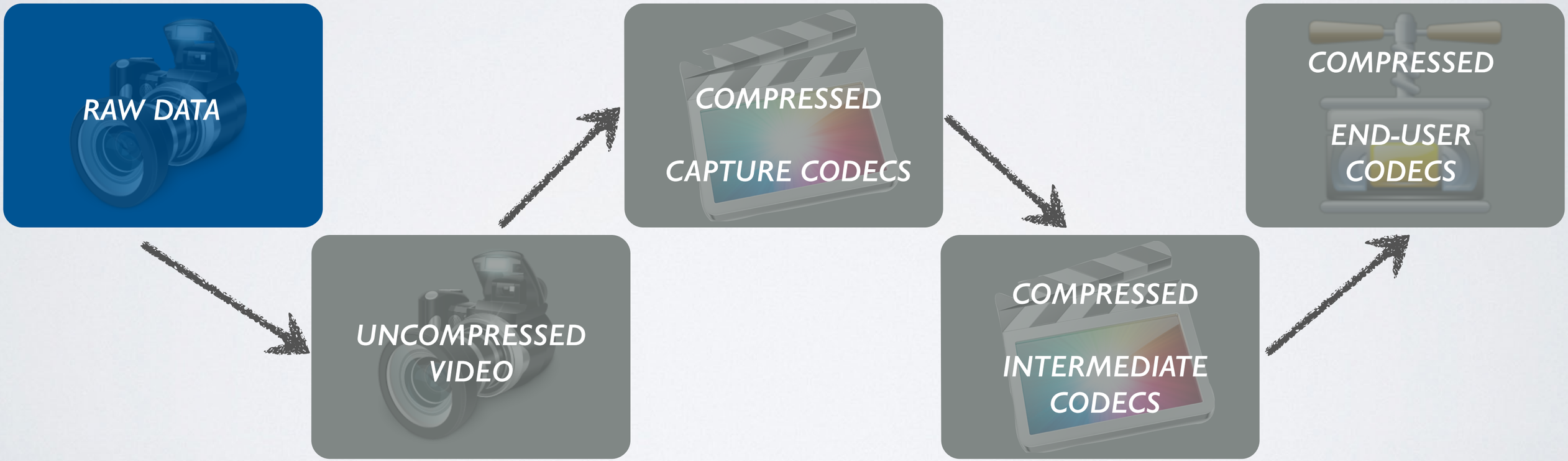
Uncompressed simply can't be recorded on a camera because of the size of the data

A smaller, lighter CODEC is needed for recording

# COMPRESSION

There are several types of compression, each with a different goal but they fall into two main categories.

CODECs designed to be edited (intermediate CODECs) and CODECs designed to be meet deliverables



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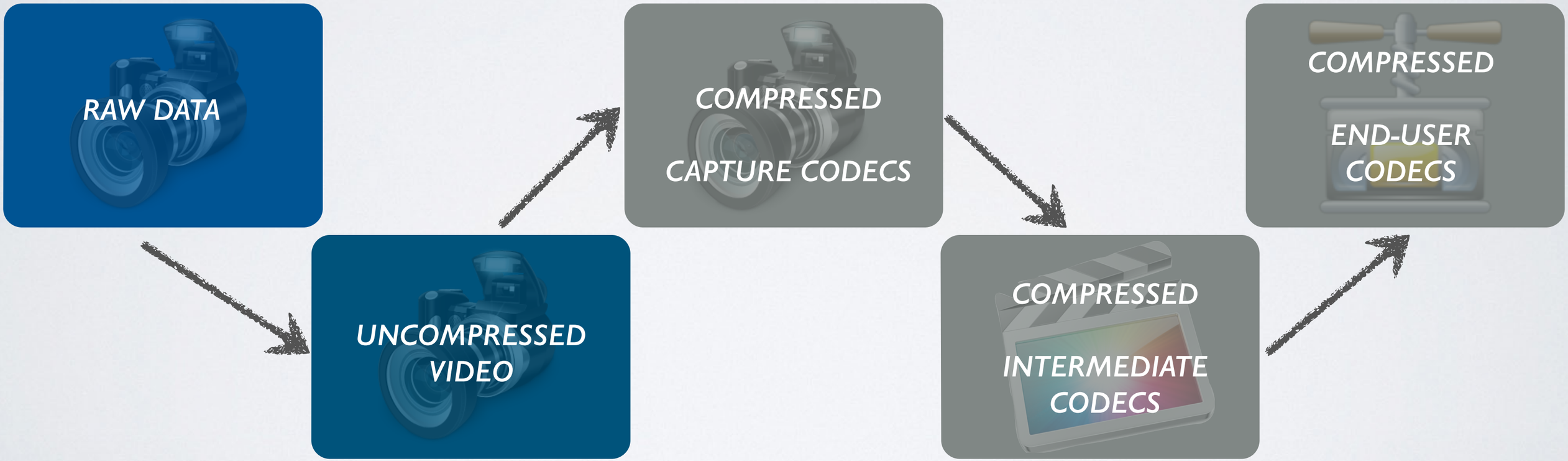

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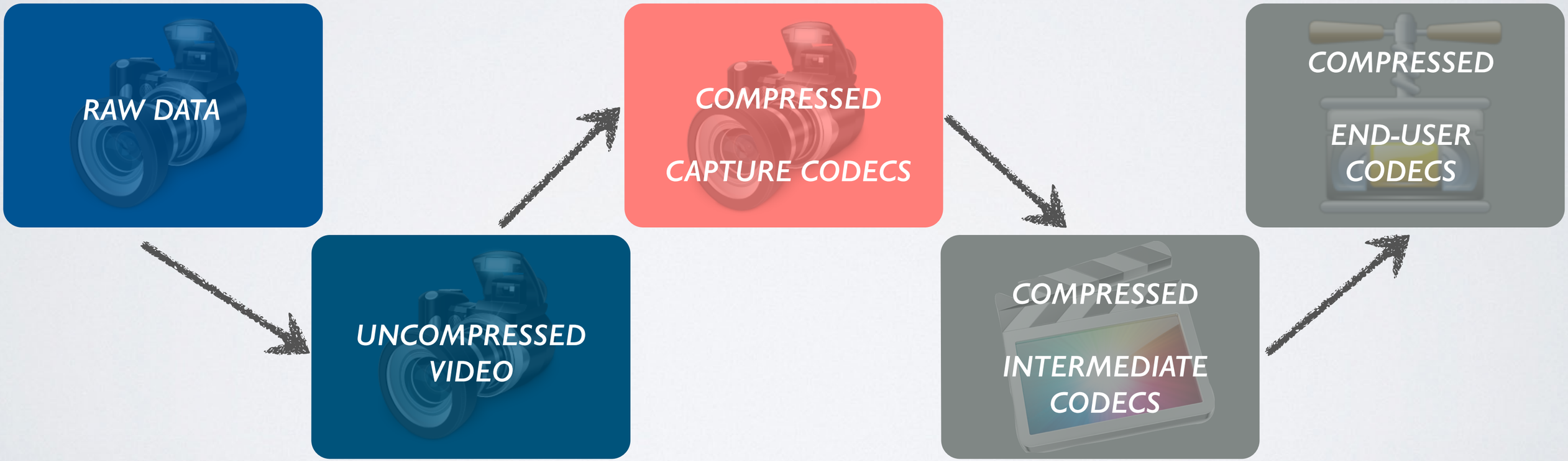

# COMMON RECORDING CODECS

RED - CODEC native to the popular RED cameras

HDCAM and D5 - High end tape formats

DVCPro HD - Another highend tape format competitive with HDCAM

XDCAM - A popular professional format used in file recorders based on MPEG-2

DV  25 & 50 - An old but popular CODEC for ENG work and consumer use

MPEG-2 (used ambiguously)

MPEG-4 (used ambiguously)

H.264 / AVCHD

XAVC - Sony's version of H.264

And Intermediate CODEC's?

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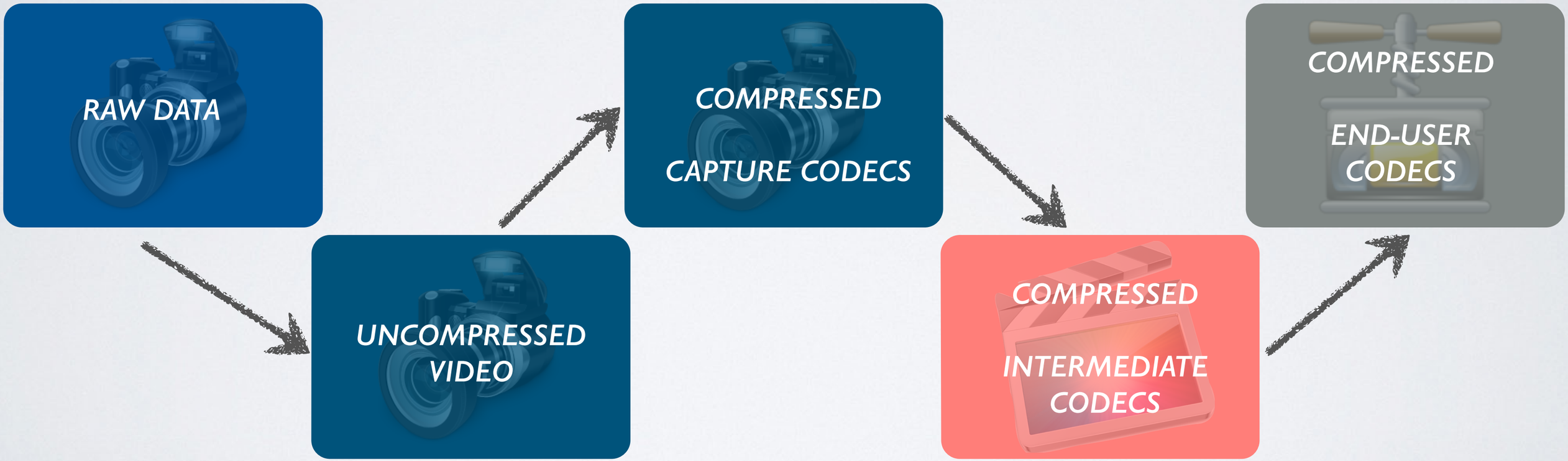

# BALANCING THE SCALES

Paradox:

Recording CODECs are efficient but very lossy.

Lossy video losses quality up front and with each "generation" of compression and tends to "fall apart in post"

Highly compressed CODEC's require substantial computational power

We need Goldilocks!

# INTERMEDIATE CODECS

Common CODECs for editing (intermediate CODECs) include:

ProRes - Considered a "lossy" CODEC, it's actual loss is much less than 1% while at the same taking up 75% less space than uncompressed. Intra-frame CODEC

DNxHD - Very similar to ProRes, made by competitor AVID

CineForm - One of the original intermediate CODEC's now largely defunct

JPEG2000 - though not really an intermediate CODEC it is of equal or slightly superior quality compared to ProRes or DNxHD and is occasionally used at an intermediate or capture codec

High Profile H.264 variants such as XAVC

# COMPRESSION

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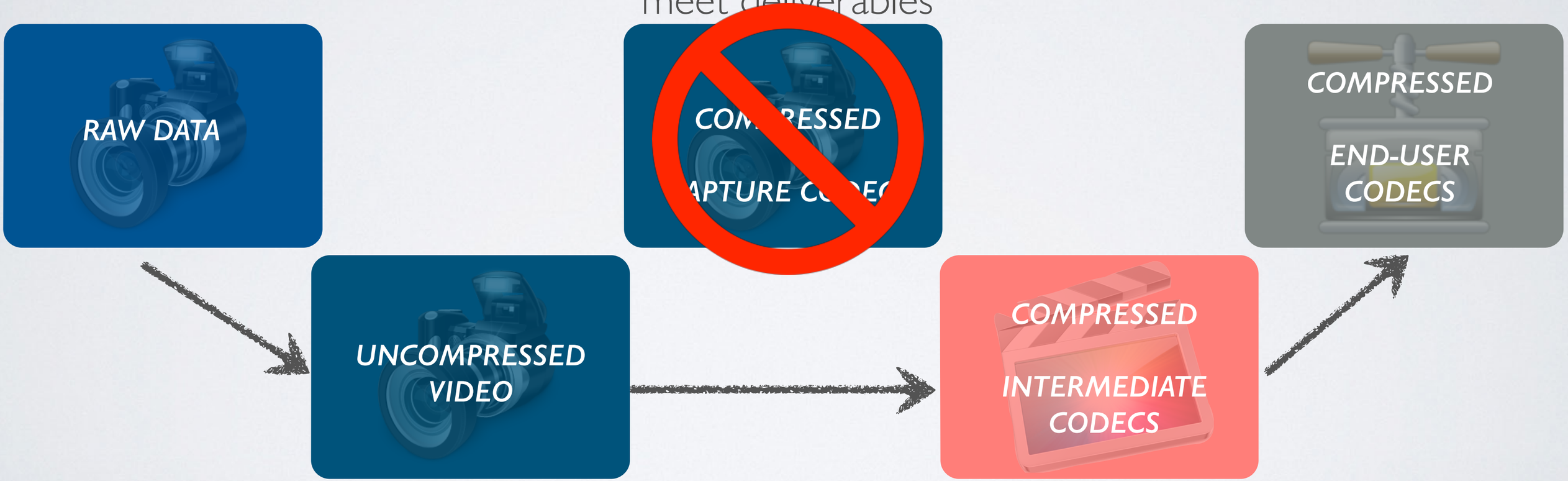


# RAPPERS

Video codecs are placed inside of containers for delivery.

These containers can be thought of just like any other container whether a jar, Tupperware, pot, whatever, it's just a place to put things.

Common things to put in a container is video data, audio data, closed captioning, timecode data, informational metadata.

There is no such thing as a QuickTime or Flash Video. There are QuickTime and Flash containers but the video inside of them is comprised of CODECS

Common containers include .mov, .f4v, .avi, .ts/.mts, .mkv, .mp4

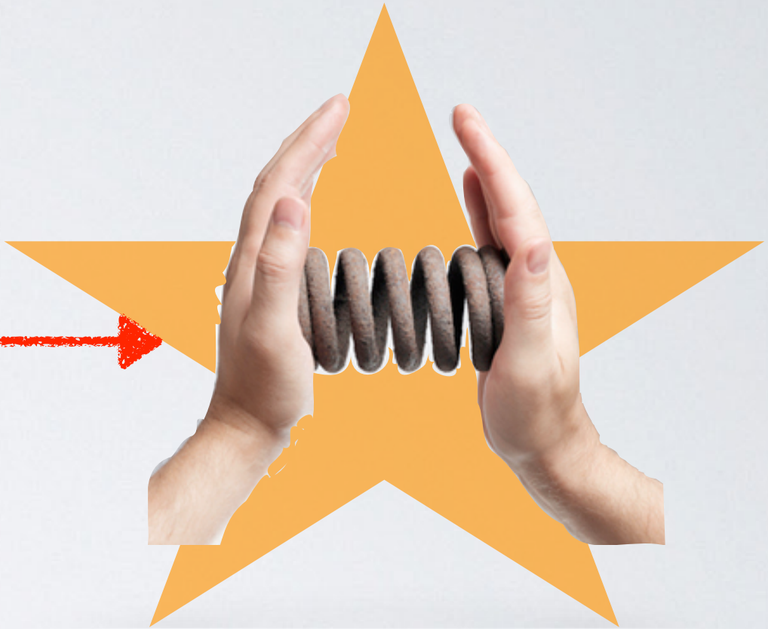
# WORKFLOW

Getting video from point A to B

**Real World**

**Camera / Capture / Digitizer**

**Editor**



**Deliverables**

# PROBLEMS W/ PRODUCTION CODECS

Production grade CODECs are generally very good. Intermediate CODECs are often 10-20% as large as uncompressed but are only degraded 1-2% to the eye. They are also easier to process.

**BUT**

It's still bit compared to what consumers and infrastructure can deal with.

ProRes HQ video requires about 1.5 GB per minute for 1080 HD

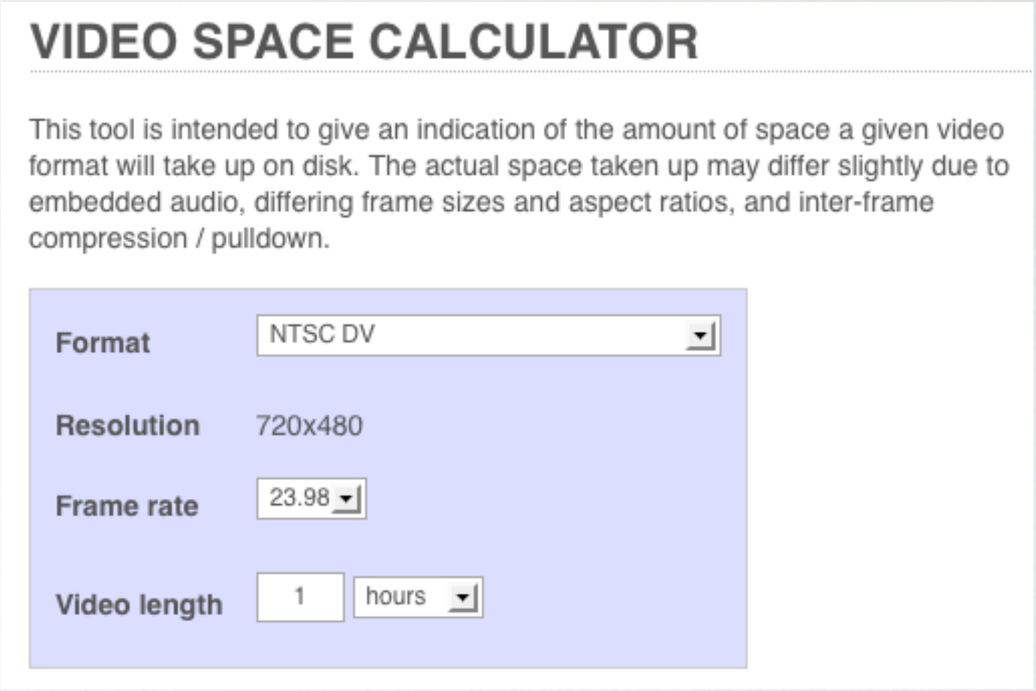
The same video can require 150Mb/s to playback and record

USB can support 480Mb/s, Firewire 800Mb/s, GigE is 1000Mb/s

Consumer harddrive can only playback about 400Mb/s

The US television channels can only support 38 Mb/s

The average home broadband internet speed is 6.6Mb/s in the US



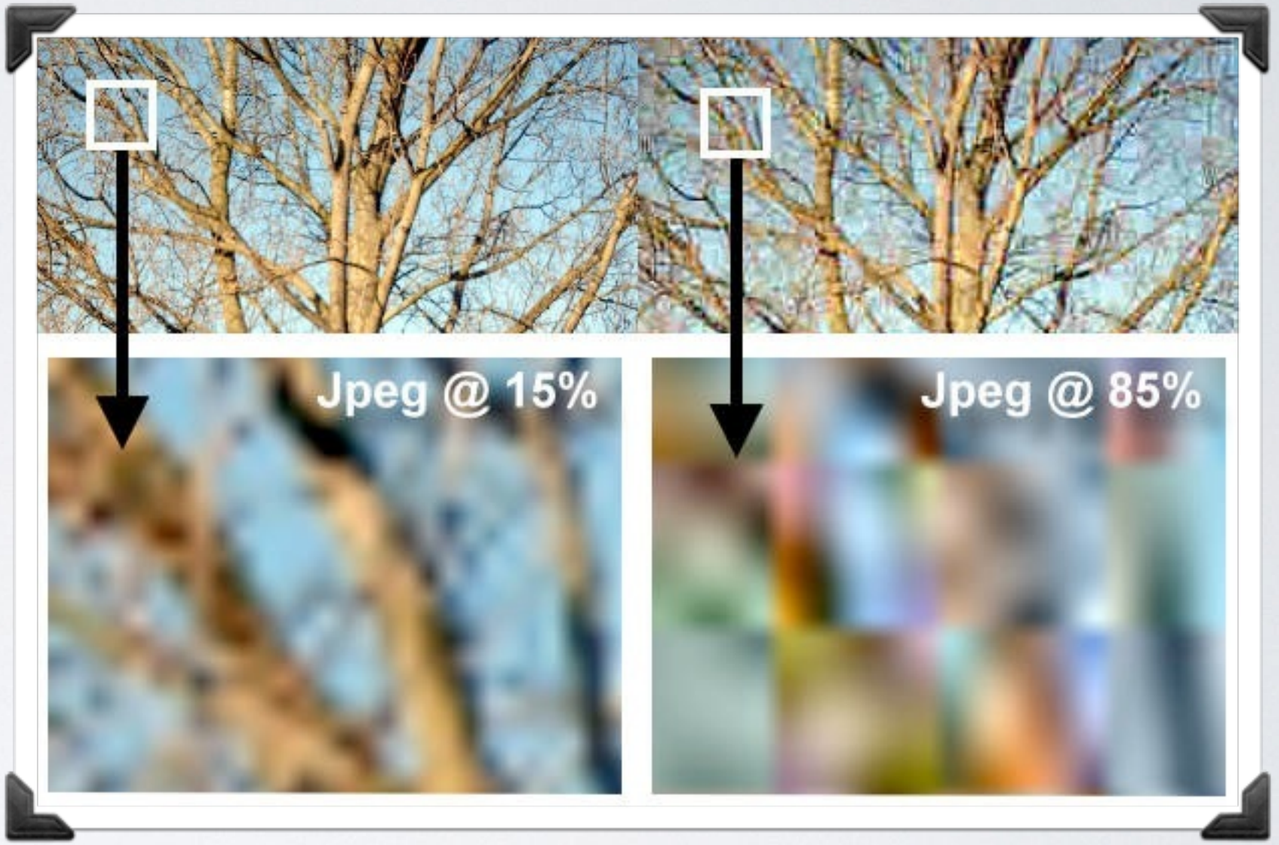

http://www.digitalrebellion.com/webapps/video_calc.html

# SO WE STILL HAVE TO MAKE THE VIDEO SMALLER

# HOW DO WE COMPRESS VIDEO?

# INTRAFRAME

Intra-frame Compression - We compress each video frame much like we compress a photo with JPEG



# INTERFRAME

Inter-frame Compression - We look at other frames and compress them relative to each other.

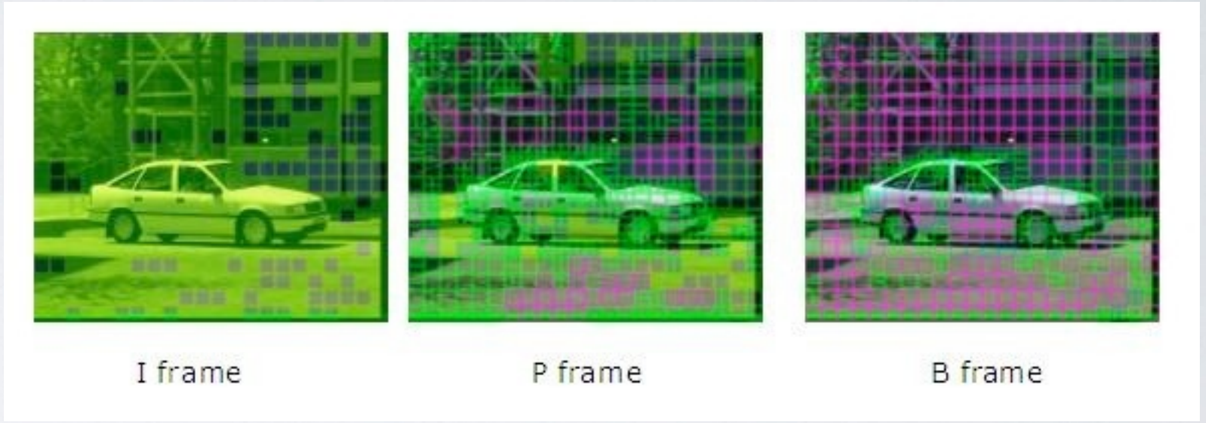
This is in effect compressing along a timeline so this also called temporal compression

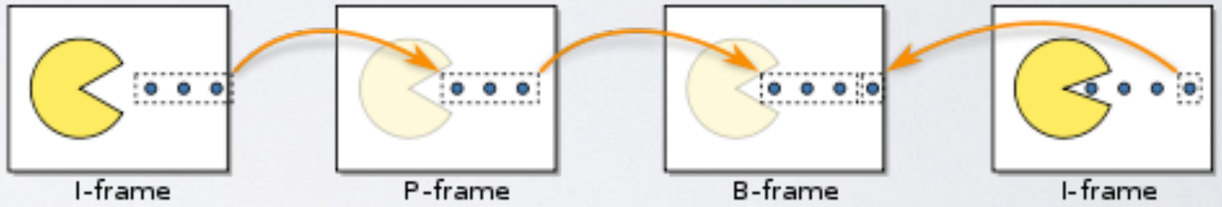
**I-Frames** are "Intra Coded" frames, they are "full frames" where every pixel is coded.

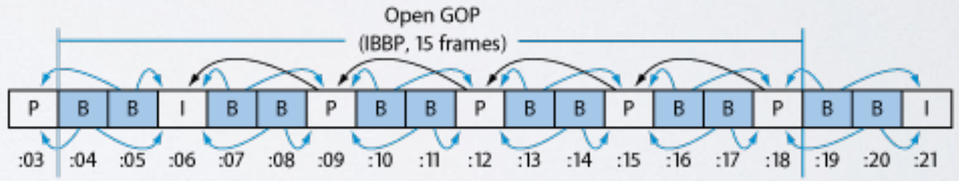
**P-Frames** are "Predicted" frames, meaning they analyzing the previous frame and showing only the differences. This usually takes 50% less space than an I-Frame.

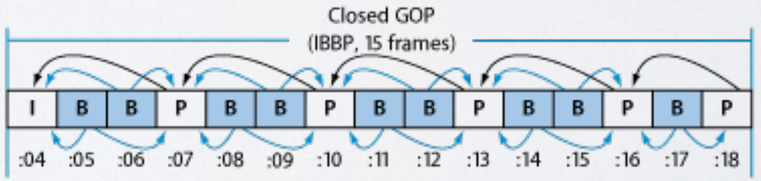
**B-Frames** are "Bi-Predictive" frames, this means they look at the previous frame and next frame then show only the differences. Uses about 25% of the space of an I-Frame.

**GOP** - Group Of Pictures, the algorithm of I P & B frames.



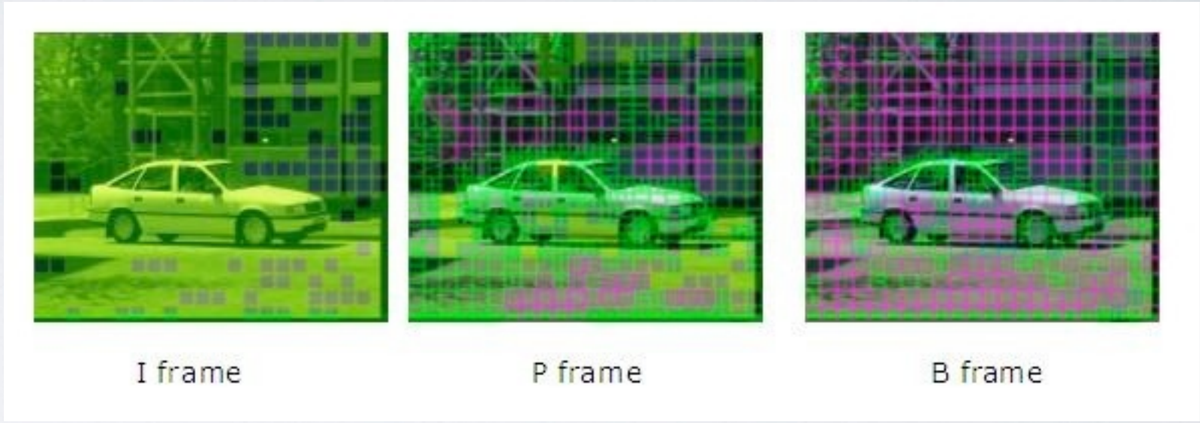



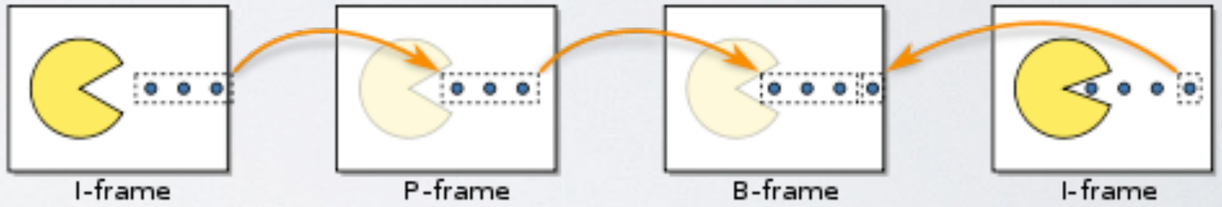



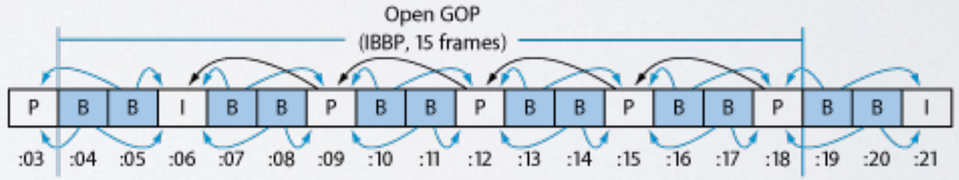



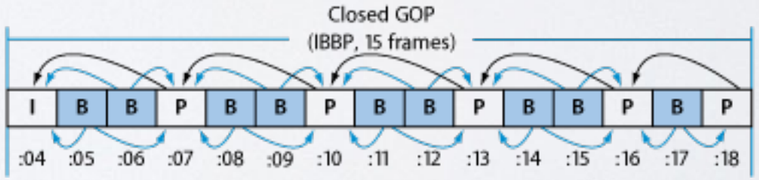
# HOW DO WE COMPRESS VIDEO?

The MPEG family of CODECs (both MPEG-2 and MPEG-4) uses this type of coding.



# H.264/AVCHD QUESTIONS

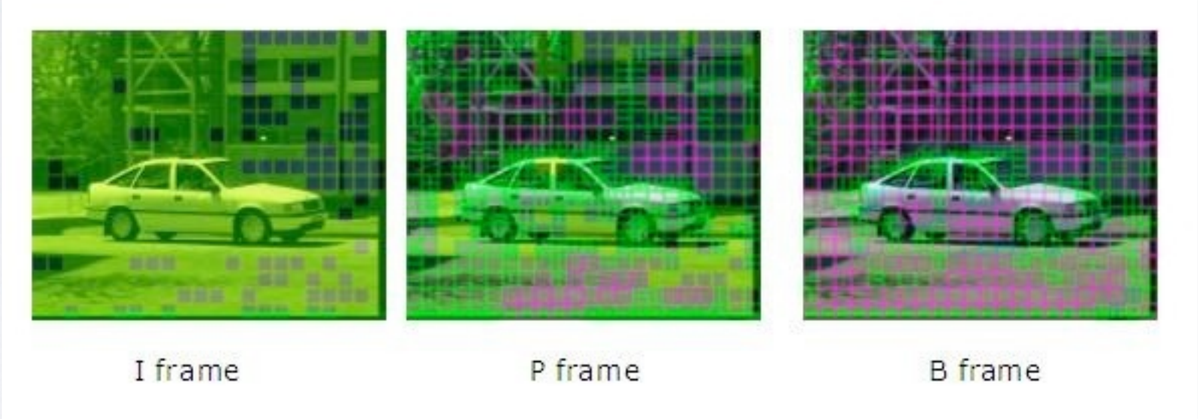
What is h.264?

This a CODEC standard

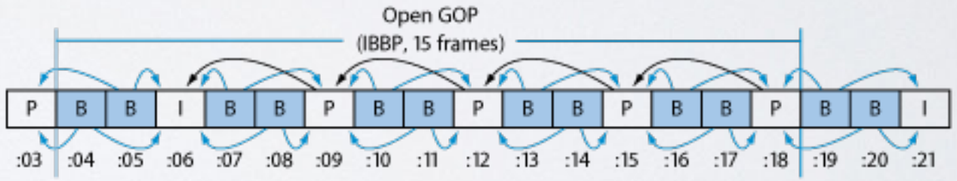
IT IS NOT A CODEC but a standard and not even one standard but a family of standards.

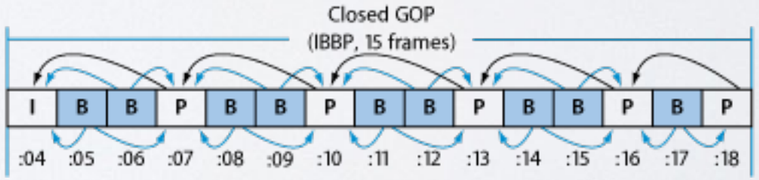
There are many different profiles available to h.264 to meet many different applications.

There are also many different performance levels.







# ALL DONE!

# JUST KIDDING!!!

You have a project due next week

https://www.dropbox.com/s/ephpfyj0qikc4pp/Video_Tech_101_Homework-Lesson_2.docx

# SCENARIO 1

Congratulations!!! You have just been hired in the marketing department of Joe's Widget Factory. Joe, the 68-year-old industrialist and founder of the company has just heard about "this social media thing" and how it can be used to show products to a large audience. He has created your position and given you a budget of $10,000 to purchase equipment. He has also defined expectations; the videos must be very high quality and produced rapidly. You have ascertained from a quick, eye-ball needs assessment that there is little to no equipment on site to use so you're starting from scratch. You will also be making the videos in a relatively small location, not having to travel with the equipment much. The director of marketing, who you report to, has ask you to write up a plan outlining what equipment you would like to purchase that she can give to Procurement. The IT department, who has to sign off on the project, believes the budget is high and you should be able to do this with an iPhone. Please provide technical justifications for your recommendation that she can use to get the CIO's sign off.

# SCENARIO 2

You manage a student media department within your student affairs division. The students often mentor with local media producers and even exchange or contribute content. It's become apparent that your tape-based cameras are at the end-of-life and your budget lifecycle funding has just come allowing you to replace them. Your students shoot news style productions (ENG) and documentaries. They do air these on the local access channel and often under tight deadline. Because of this students need a camera or config and workflow that is robust, rugged, accepts professional audio, and is very fast to work with. Conversely, when used as a documentary camera, the footage needs to be high quality enough to be accepted for various local festivals. The ENG format requires portable lighting, lightweight camera supports, and portability. The cameras and workflow need to be no-muss-no-fuss, it needs to "just work". The university said that more monies may exist beyond the camera lifecycle funding but a good justification is needed. This is a good time to really take your department to the next level by adding other key pieces to your outfit but you need to convince a technical authority of the quality benefits.

# SCENARIO 3

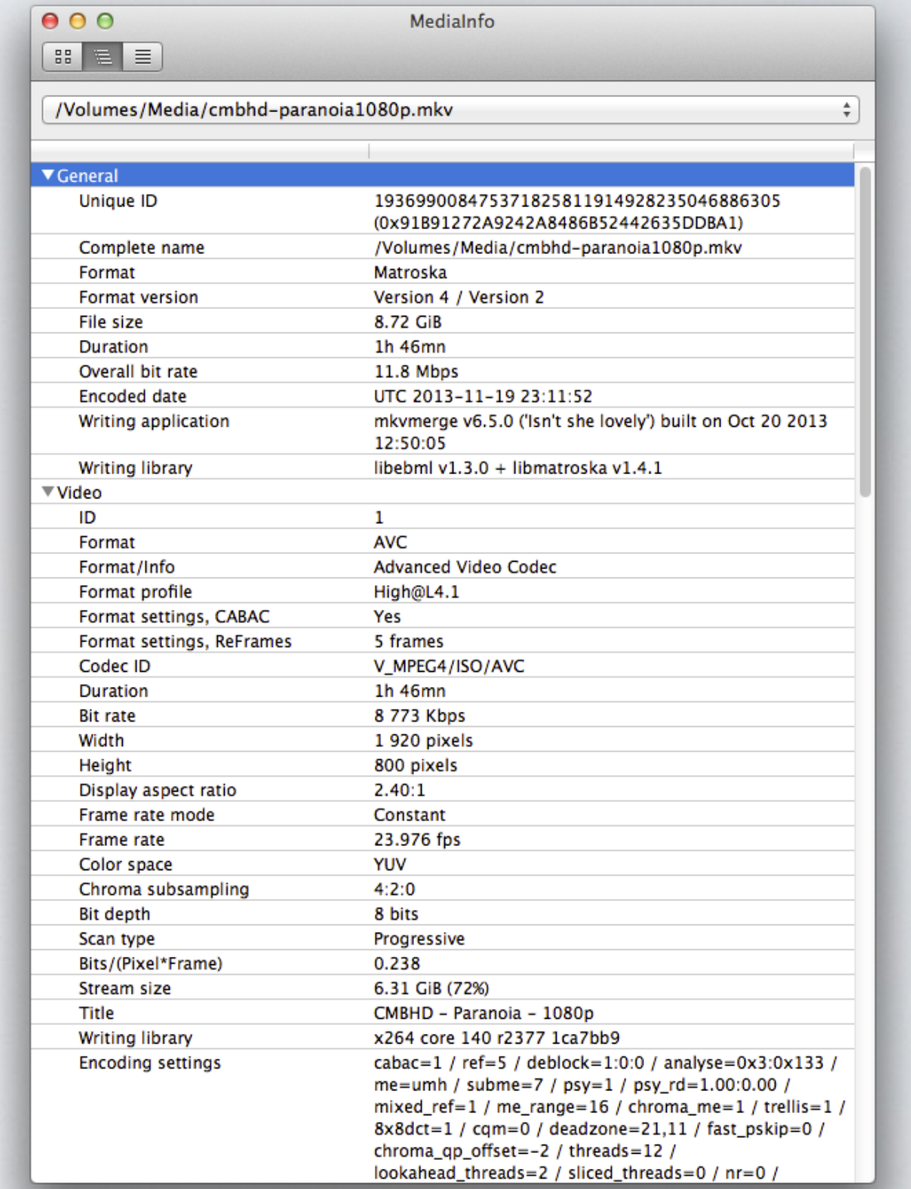
Having just finished your MBA you never thought you would have to understand video production when you went to work as a manager with LendingBanana.com, an online auto loan company. The companies CEO is charismatic and likes to engage with employees via taped web announcements, preferring them to "boring email memo's" as he calls them. The strategy has worked well for him and he wants to go from "behind the desk" videos he shoots with a web cam to a 10'x12' mini-studio. You know he wears $1000 suits and drives a high-end luxury car so your feeling is that he is concerned about image and won't want put himself in a situation where an announcement looks cheap. But, you know that he is also a shrewd businessman and counts every penny. You feel as if you lead this to a good outcome it will be a great win for you since it's a CEO pet project. On your way out of the meeting, his executive assistant asks you to write up a proposal outlining what equipment you would want to buy. You weren't give a budget but feel that if you write a good justification the equipment you want he will go for it. You decide that a budget of $13,000 is appropriate for equipment in the small studio, quality is important and rendering speed is paramount so same day messages can be turned around.

# SCENARIO 4

The decision was hard but you finally made it, you just quit your job and began freelancing. You are a skilled and creative person recognized in the industry as among the most talented in your market. But the media company you worked with provided you with an engineer to make technical decisions for you, decisions you will now have to make yourself. You have never been much of a tech person but need to learn quickly if you're going to make it. An investor/partner that believes in your talent is loaning $12,000 in capital money to get your company off the ground. You plan to do this by taking a dozen freelance jobs that you have already lined up over the next six months. If you can get these jobs done, you'll have plenty of money to reinvest. Almost all of your work is in the field, very little in your home studio. You need to build a single ultra high quality camera rig that focuses on value. You need to get as much quality out of a single camera as you can for the money you're spending. You also need lights, camera support, recording media, and an editor. Quality is much more important than fast rendering computers but you do still need enough horsepower to meet deliverables over six months. The investor does require reports for the capital and operational investment. He wants you to write up a technically justifiable plan for the capital equipment expenses that will reassure him you can meet the quality needs the clients require.

# MORE TIPS!!!

# MEDIAINFO IS A GODSEND

# PRODUCTION QUALITY MATTERS

# AUDIO MATTERS