

VIDEO TECHNOLOGY, ENCODING, DELIVERY

DIGITAL MEDIA E-5

EXPLORING DIGITAL MEDIA

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FRAME RATES



Movie rec. size

1920x1080 30fps 60:00
Low comp. (intra frame, ALL-I)

- | | |
|---------------|---------------|
| 1920 30 ALL-I | 1280 60 ALL-I |
| 1920 30 IPB | 1280 60 IPB |
| 1920 24 ALL-I | 640 30 IPB |
| 1920 24 IPB | |

Canon

File Format

- XAVC S 4K
- XAVC S HD
- AVCHD
- MP4

Sony

Record Setting

- 60p 50M
- 30p 50M
- 24p 50M
- 120p 100M
- 120p 60M

Movie settings

Frame size/frame rate

- 1080 P 60 1920x1080; 60p
- 1080 P 30 1920x1080; 30p
- 1080 P 24 1920x1080; 24p
- 720 P 60 1280x 720; 60p
- 424 P 30 640x 424; 30p

Nikon

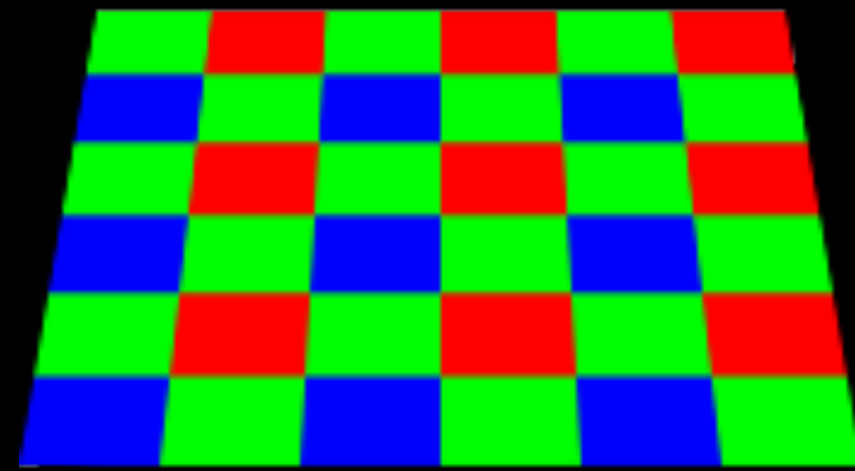
SINGLE-LENS REFLEX

CAMERAS

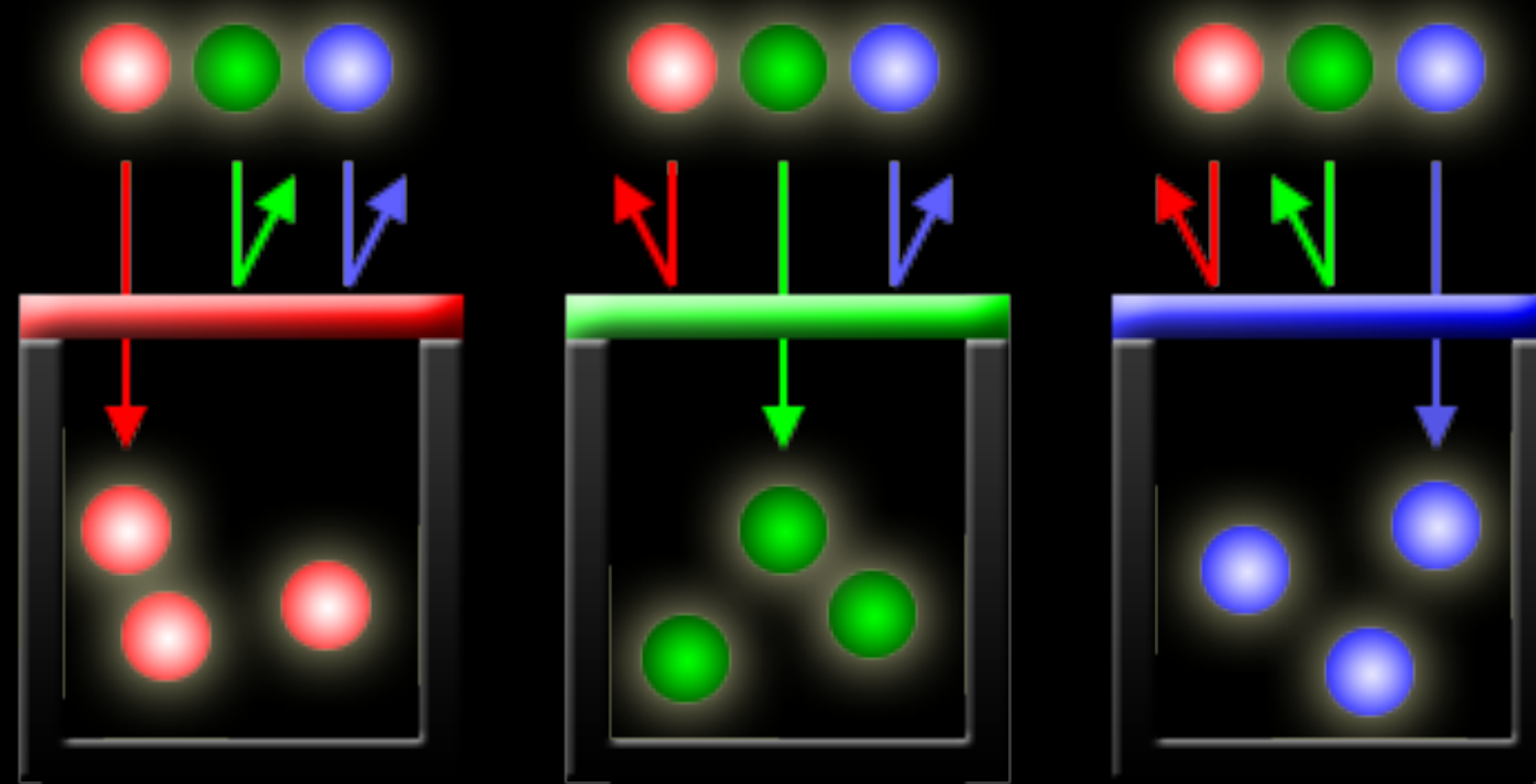


What the Camera Captures

Color Sensors (digital)



Bayer Pattern



Of Red, Green, and Blue we are most sensitive to Green information

How Big is all of this Data?

Giga/Mega/Kilo**bits** = unit of measure for data transfer (bitrate)

Giga/Mega/Kilo**bytes** = unit of measure for data storage (file size)

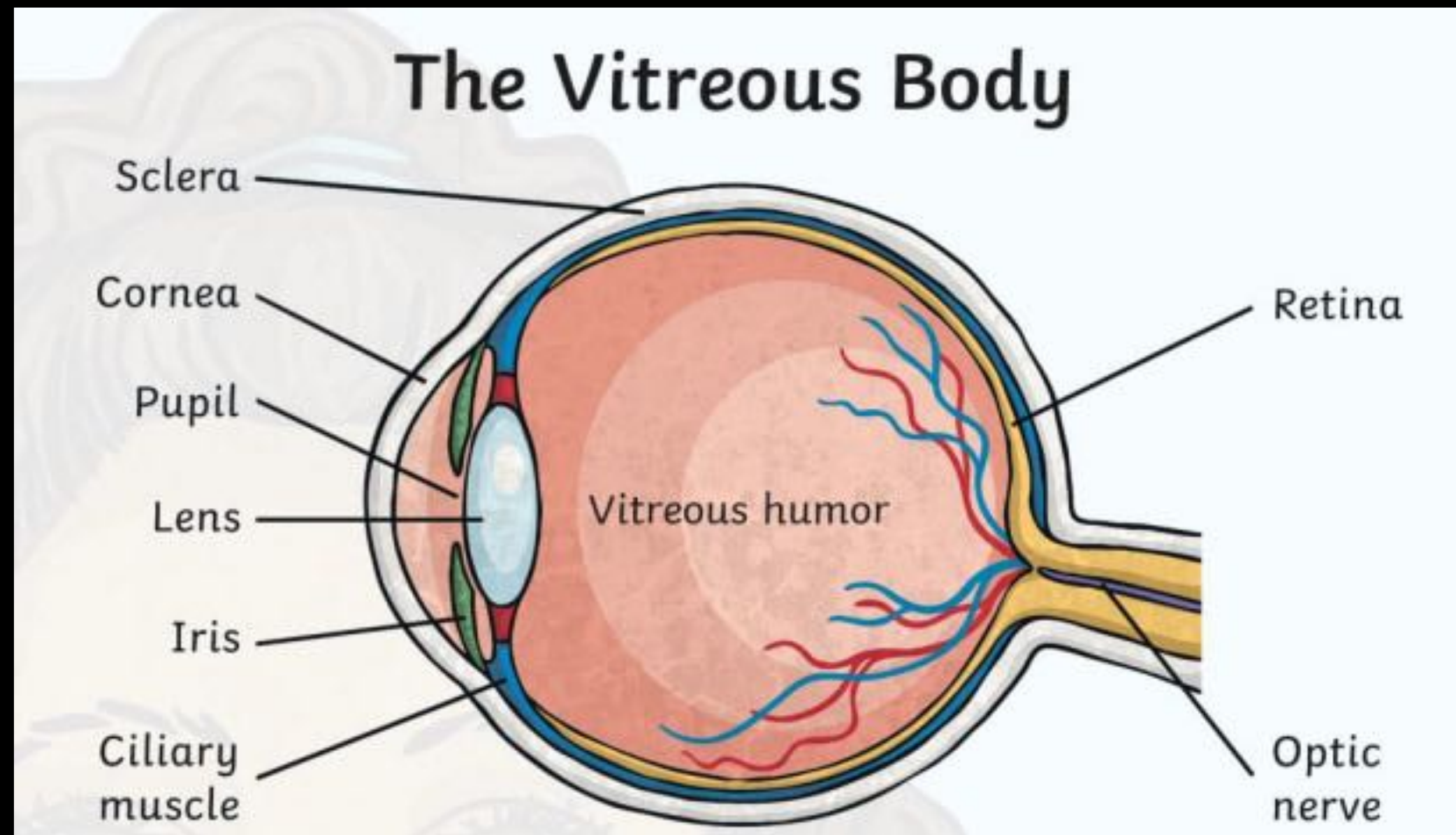
$$\text{data rate} = \text{color depth} \times \text{vertical resolution} \times \text{horizontal resolution} \times \text{refresh frequency}$$

UNCOMPRESSED VIDEO	Bit Depth	Resolution	Frame rate	Total bitrate	5 minutes of video
720p@30 8-bit	8 (*3)	1280x720	30	663 Mbps	24.86 GB
1080p@60 10-bit	10 (*3)	1920x1080	60	3.73 Gbps	140 GB
4K UHD@60 12-bit	12 (*3)	3840x2160	60	17.91 Gbps	671 GB
8K UHD@60 12-bit	12(*3)	7680 × 4320	60	71.6 Gbps	2.7 TB

How Big is all of this Data?

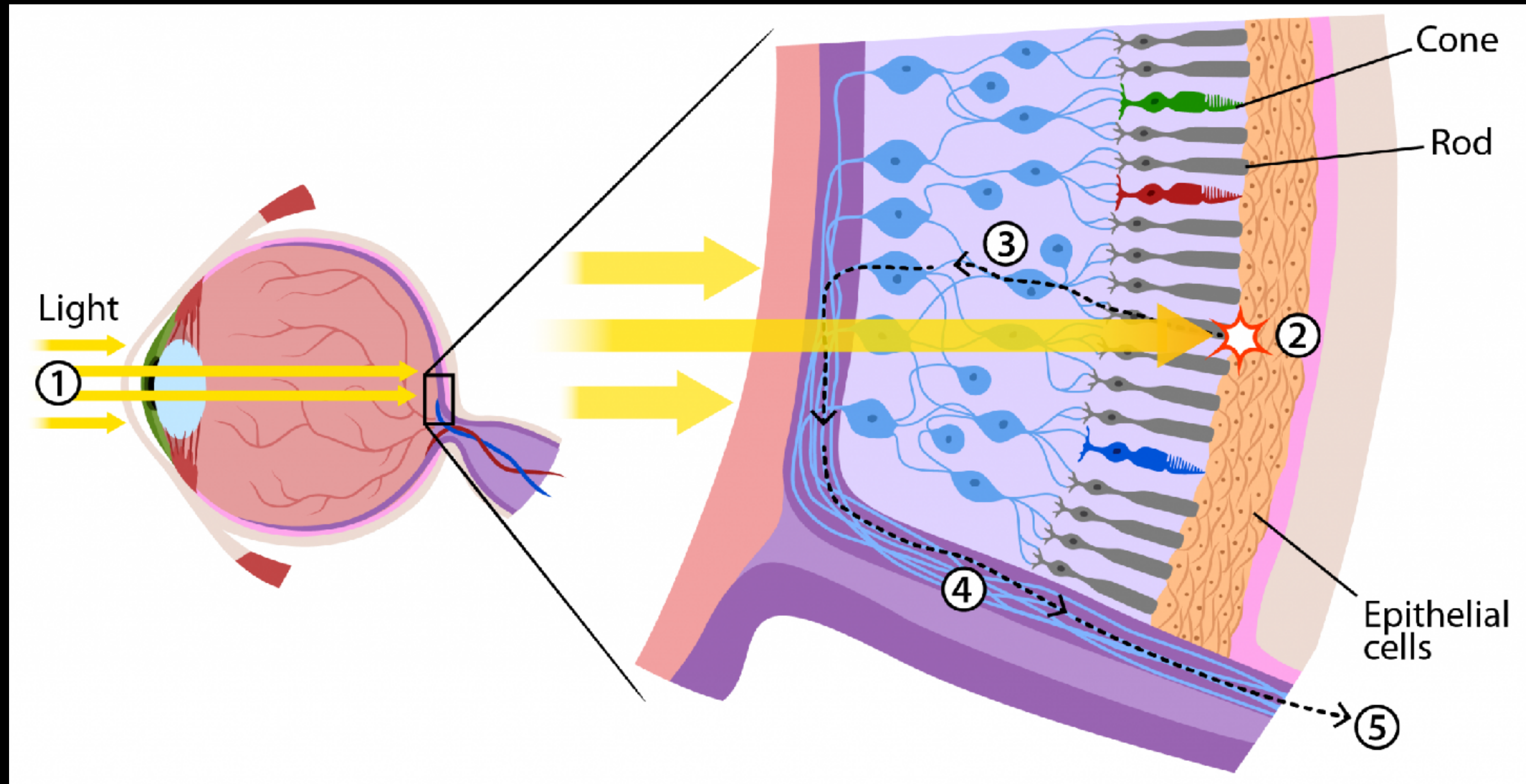
TOO BIG

What Do We Do About it?



The Human Visual System is Imperfect

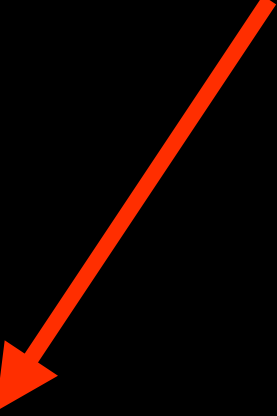
Rods and Cones



120 Million Rods
6 Million Cones

What Do We Do About it?

Spend more bits here!



More Sensitive

Less Sensitive

Brightness (Luma)

Color (Chroma)

Light Areas

Dark Areas

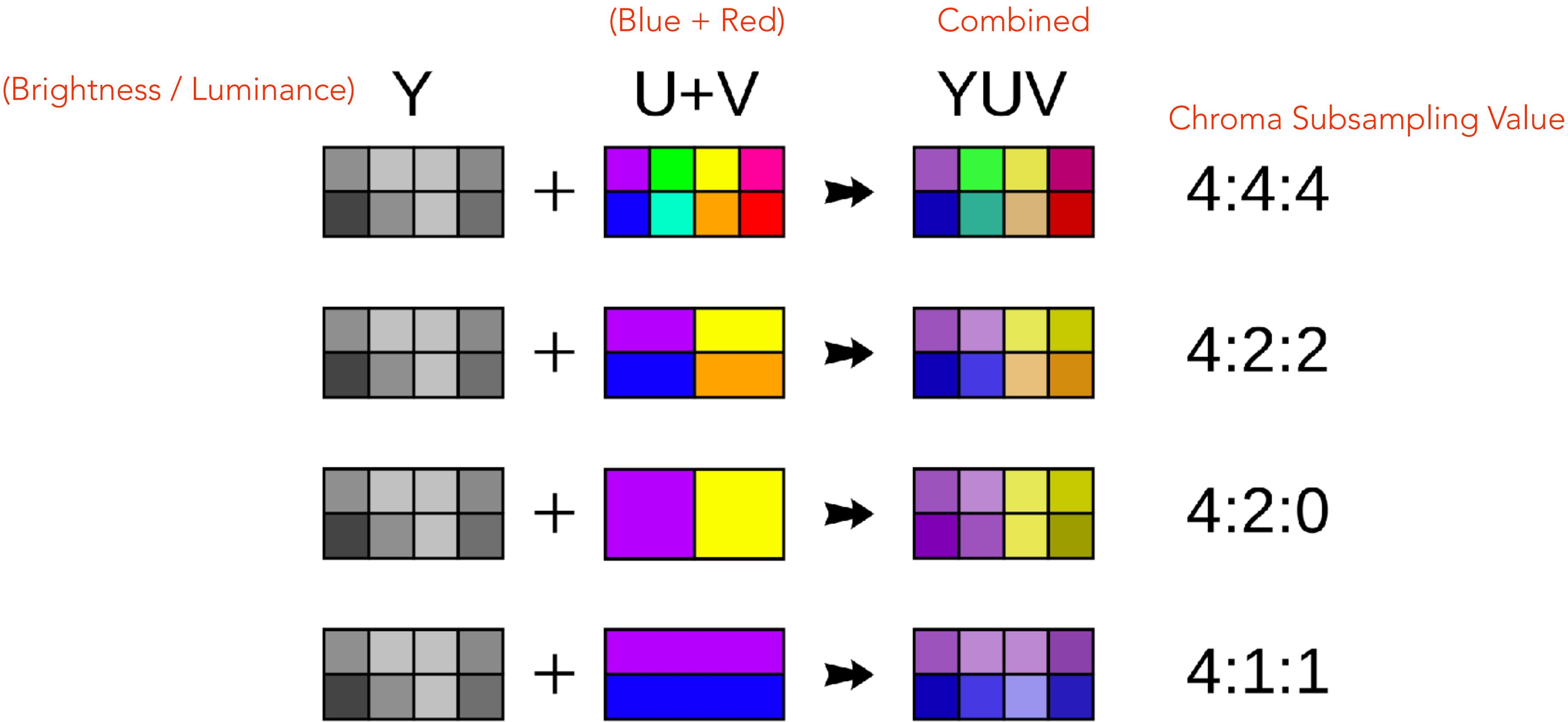
Lower Frequency Detail

High Frequency Detail

What are the components of video information?



Chroma Subsampling





WEEK 0: WELCOME

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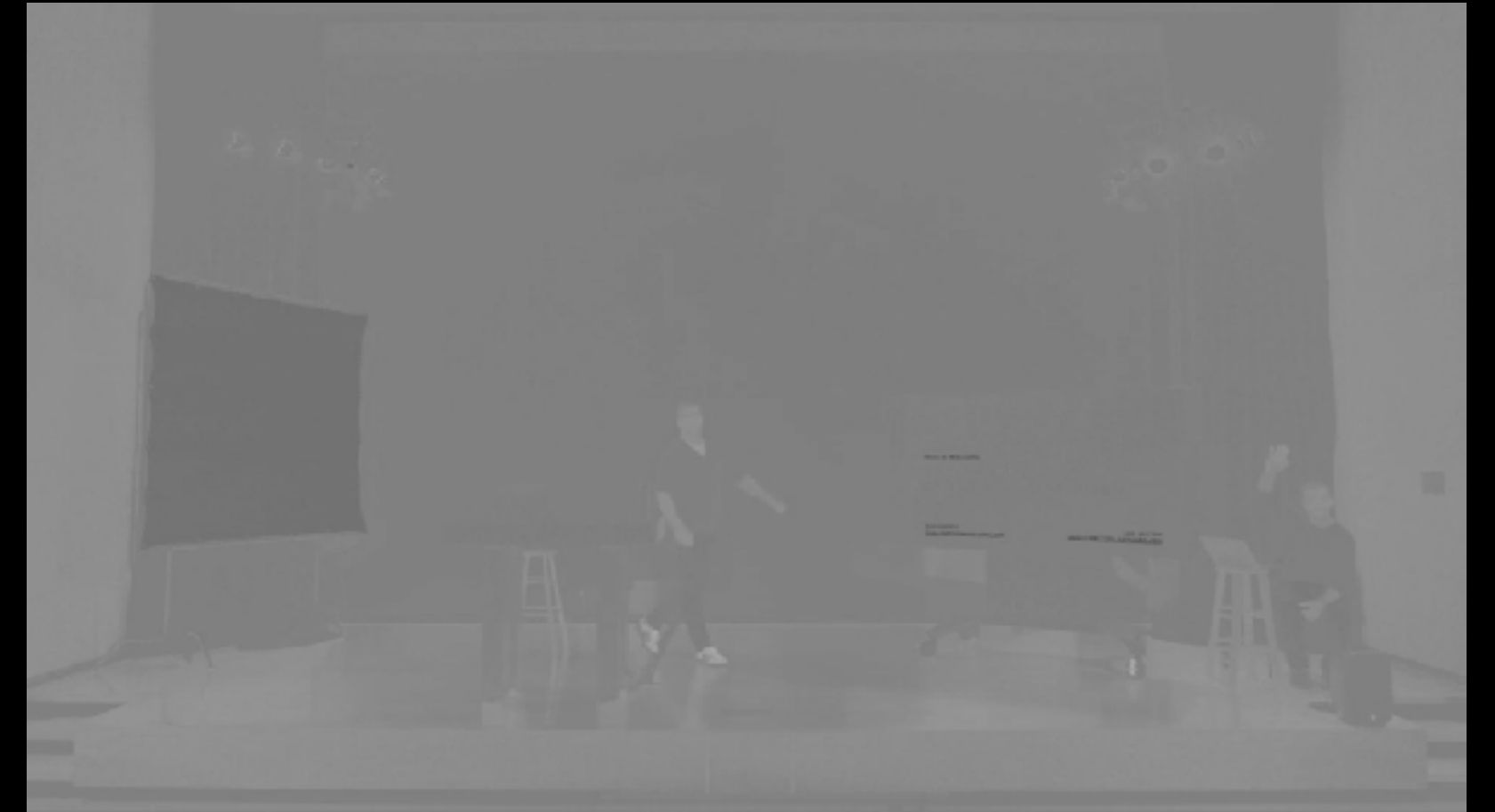
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Y (luminance)



4:2:0

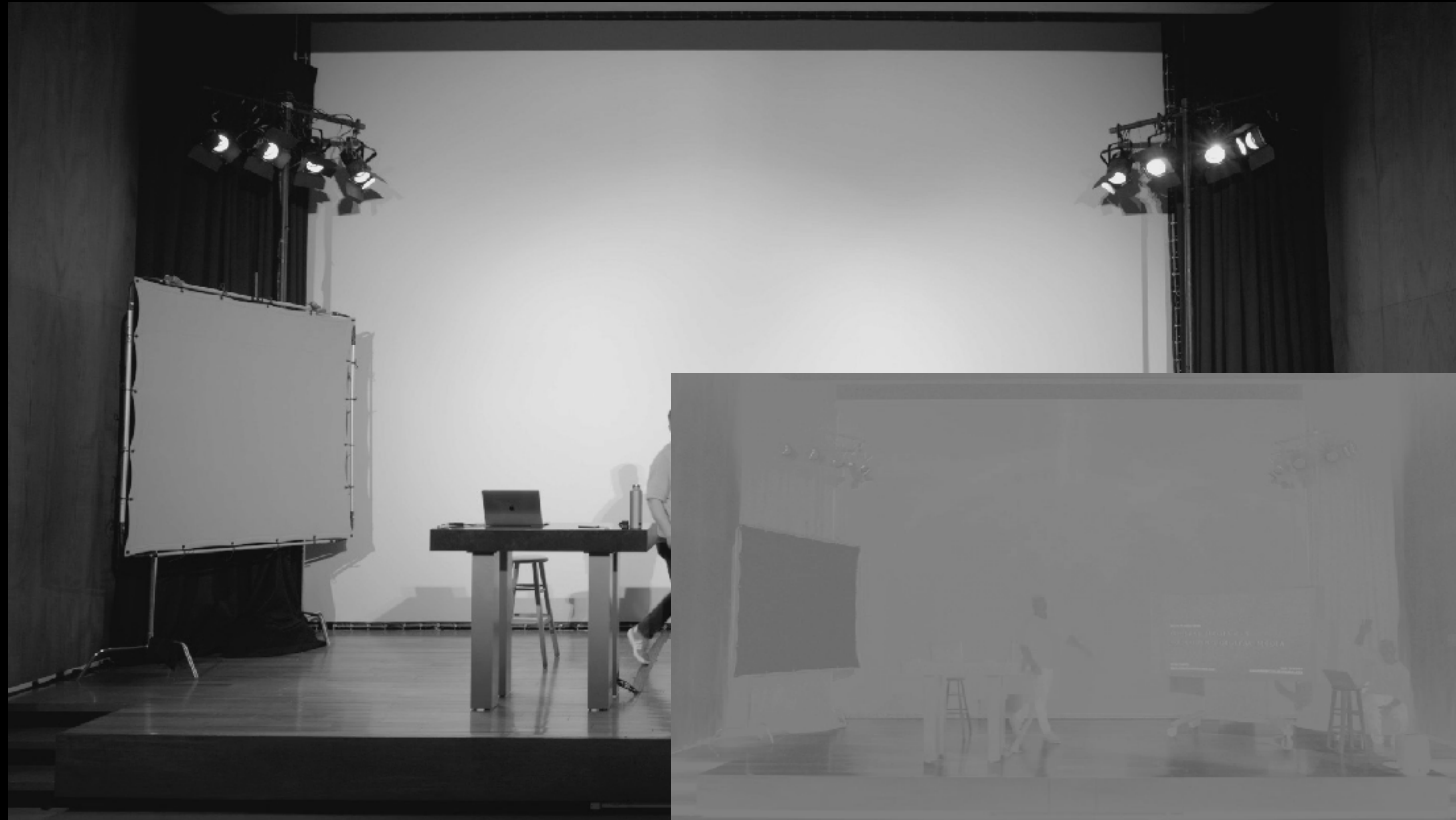
Cb (blue component)



Cr (red component)



Y (luminance)



4:2:0 (1/4 chroma information)



Chroma Subsampling



4:1:1



4:2:0



4:2:2



4:4:4



Bit Depth

8-bit, 10-bit, 12-bit, 16-bit... ????

Bit Depth

8-bit, 10-bit, 12-bit, 16-bit... ????

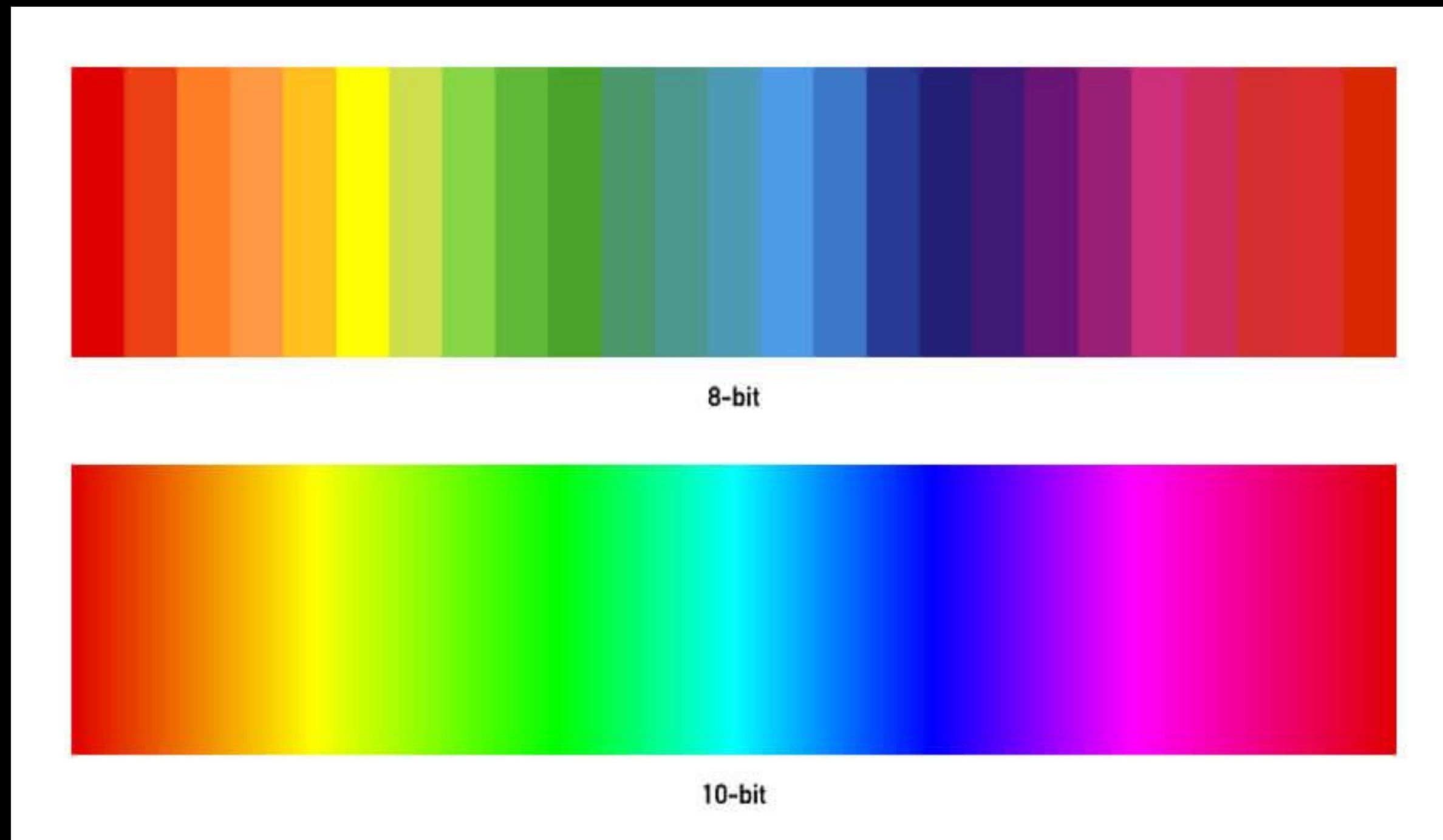
Binary Representation (base 2)

Bit-Depth	Binary Representation	Maximum Base10 Value	Number of Colors
1-bit	1	1	1
8-bit	11111111	255	16,777,216
10-bit	1111111111	1,023	1,073,741,824
12-bit	111111111111	4,095	68,719,476,736
16-bit	1111111111111111	65,536	281,474,976,710,656

Bit Depth

8-bit, 10-bit, 12-bit, 16-bit... ????

Common Artifact: Banding, especially on gradients



Storing the Data

B&H

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Sony a7 IV Mirrorless Camera

BH #SOA74 • MFR #ILCE-7M4/B | ★★★★★ 227 reviews | 155 Questions, 200 Answers

SONY Authorized Dealer

Share Print

Key Features

• 33MP Full-Frame Exmor R CMOS Sensor

• Up to 10 fps Shooting, ISO 100-51200

• 4K 60p Video in 10-Bit, S-Cinetone

• 3.68m-Dot EVF with 120 fps Refresh Rate

• 3" 1.03m-Dot Vari-Angle Touchscreen LCD

• 759-Pt. Fast Hybrid AF, Real-time Eye AF

• Focus Breathing Compensation

• 5-Axis SteadyShot Image Stabilization

• Creative Looks and Soft Skin Effect

• 4K 15p UVC/UAC Streaming via USB Type-C

Show Less

+ 15

1

Add to Cart

Add to Wish List

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Protect your Gear Add a protection plan from \$155.99 See Options

Style

Body Only With 28-70mm Lens With 24-70mm f/4 Lens

With 24-105mm Lens With 24-70mm f/2.8 Lens With 16-35mm f/2.8 Lens

Storing the Data

Internal Video Capture

Recording Modes

Codec

Chroma Subsampling

Bit Depth

H.265/XAVC HS 4:2:2 10-Bit

UHD 4K (3840 x 2160) at 23.98p/50p/59.94p [50 to 200 Mb/s]

H.265/XAVC HS 4:2:0 10-Bit

UHD 4K (3840 x 2160) at 23.98p/50p/59.94p [30 to 150 Mb/s]

H.264/XAVC S-I 4:2:2 10-Bit

UHD 4K (3840 x 2160) at 23.98p/25p/29.97p/50p/59.94p [240 to 600 Mb/s]

Full HD (1920 x 1080) at 23.98p/25p/29.97p/50p/59.94p [89 to 222 Mb/s]

XAVC S 4:2:2 10-Bit

UHD 4K (3840 x 2160) at 23.98p/25p/29.97p/50p/59.94p [100 to 200 Mb/s]

Full HD (1920 x 1080) at 23.98p/25p/29.97p/50p/59.94p [50 Mb/s]

XAVC S 4:2:0 8-Bit

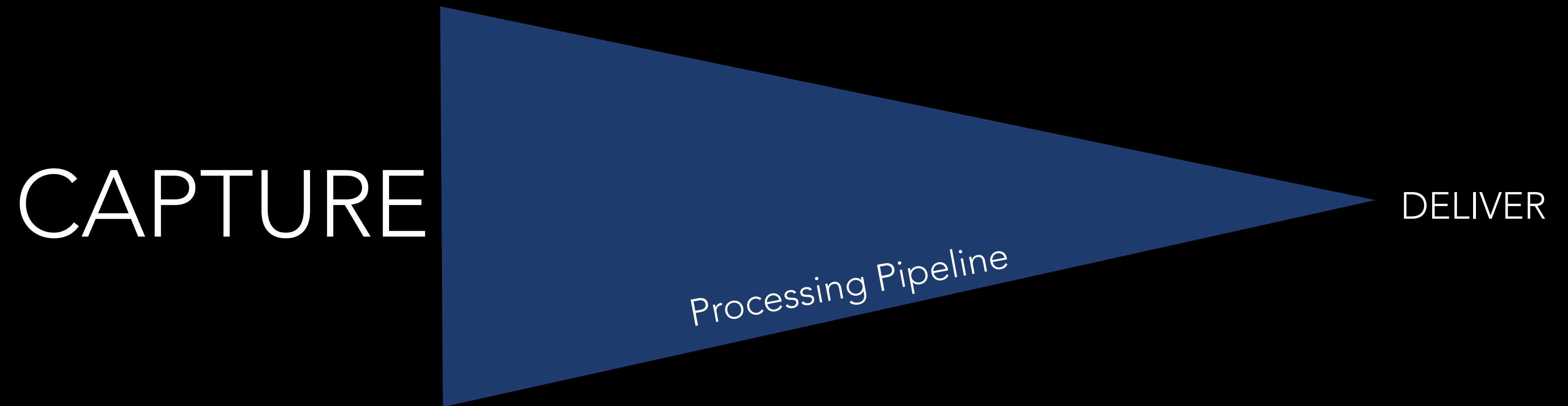
UHD 4K (3840 x 2160) at 23.98p/25p/29.97p/50p/59.94p [60 to 150 Mb/s]

Full HD (1920 x 1080) at

23.98p/25p/29.97p/50p/59.94p/100p/119.88p [16 to 100 Mb/s]

Storing The Data

Acquisition format should be higher than the delivery format

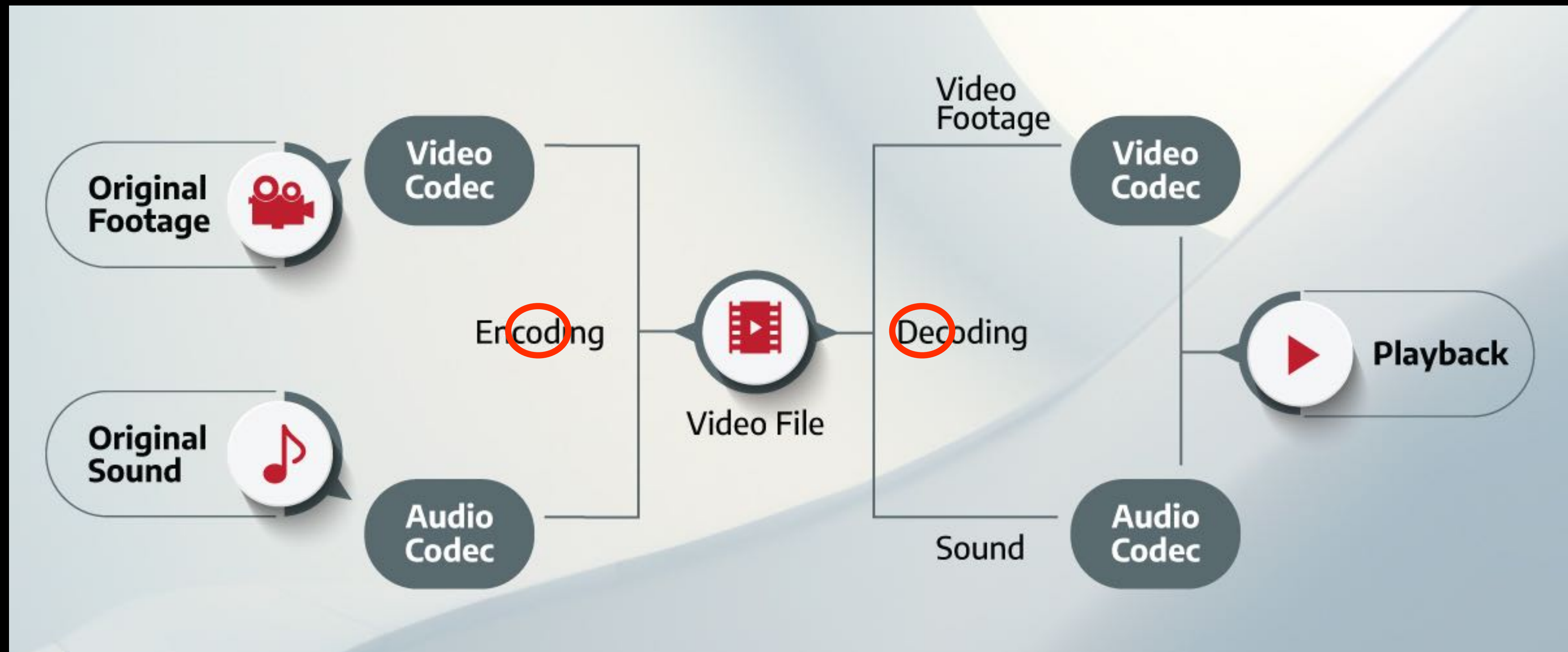


At least 10-bit 422 when possible

depends*

Video Compression

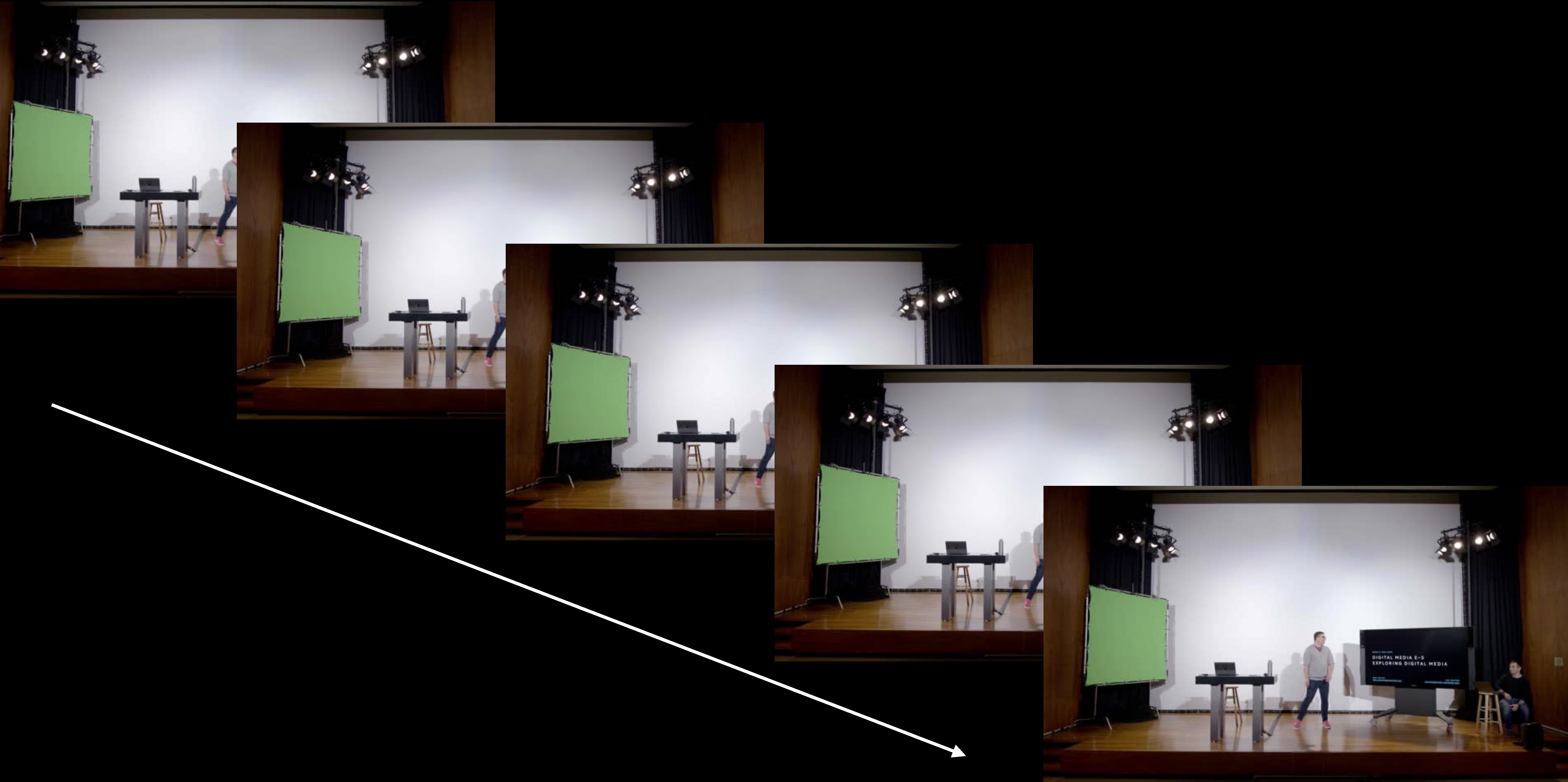
Codec



Encoder Decoder

Video Compression

Frames



Video Compression

Frames



Video Compression

Frame Types

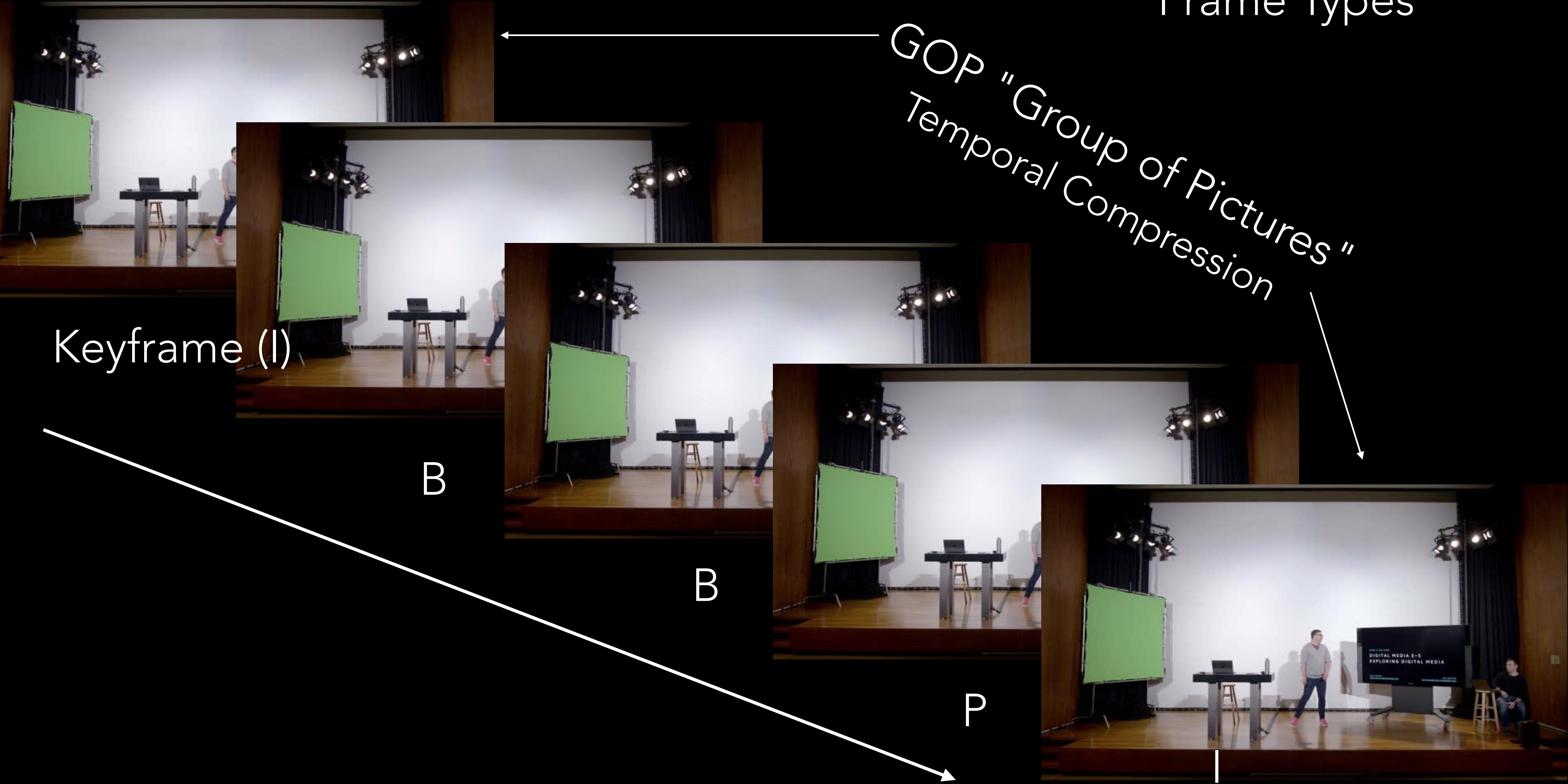
GOP "Group of Pictures"
Temporal Compression

Keyframe (I)

B

B

P



Video Compression

Frames



Video Compression

my_file.mp4

Metadata

Video Track (h264 codec)

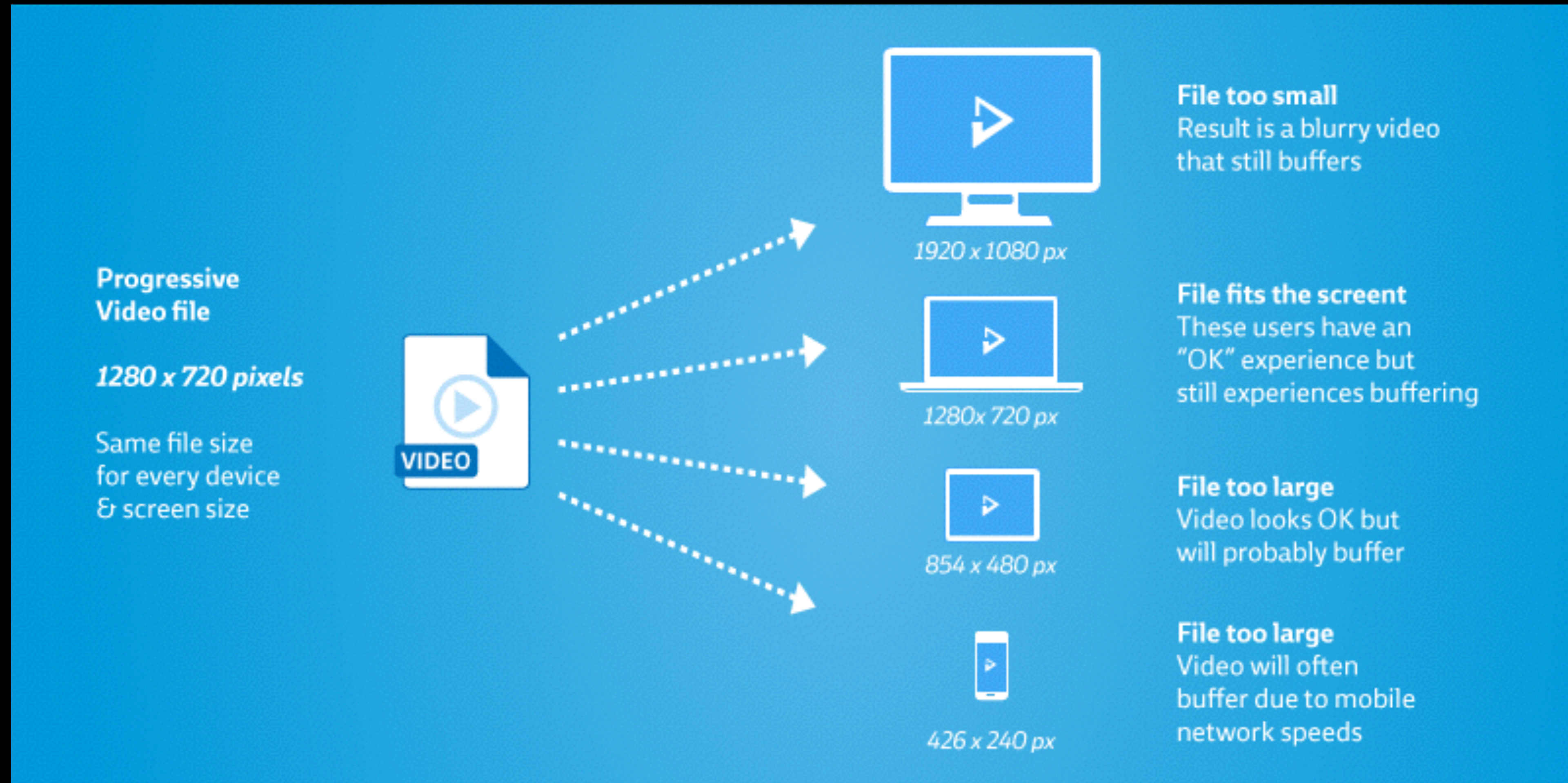
Audio Track (aac codec)

Video Delivery

How do I send you my file? How do you view it?

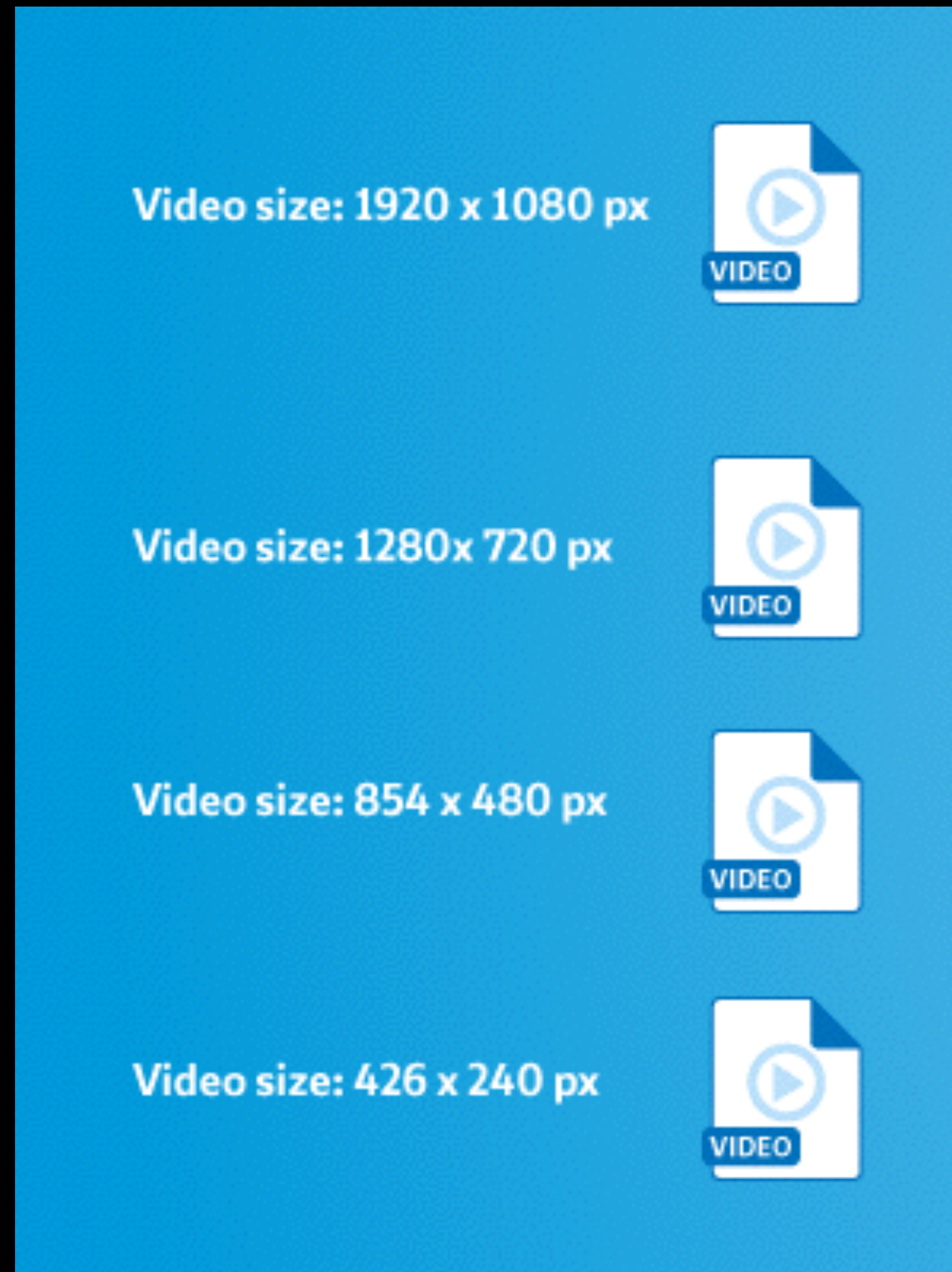
Video Delivery

Single File Approach (progressive download)



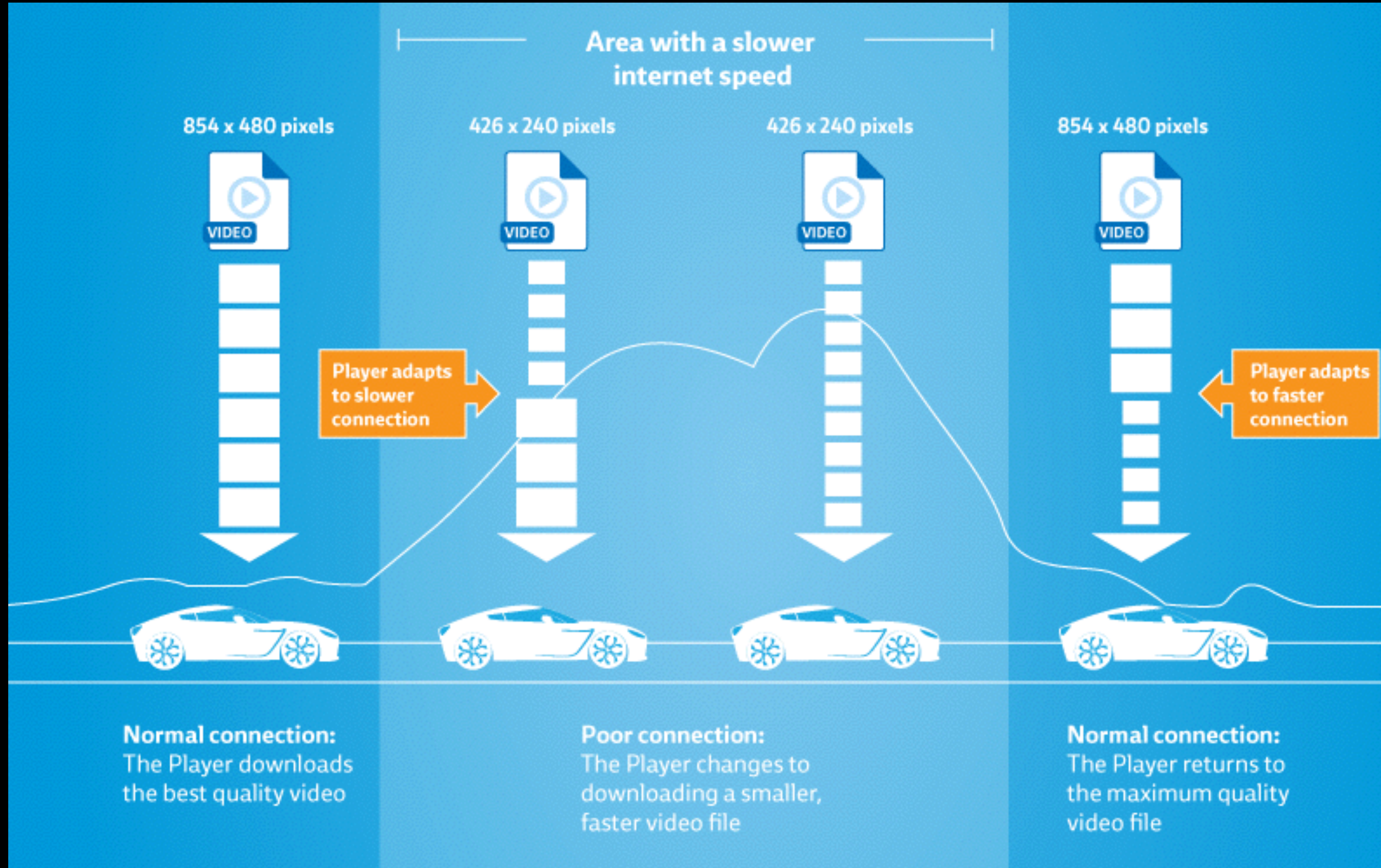
Video Delivery

Adaptive Bitrate

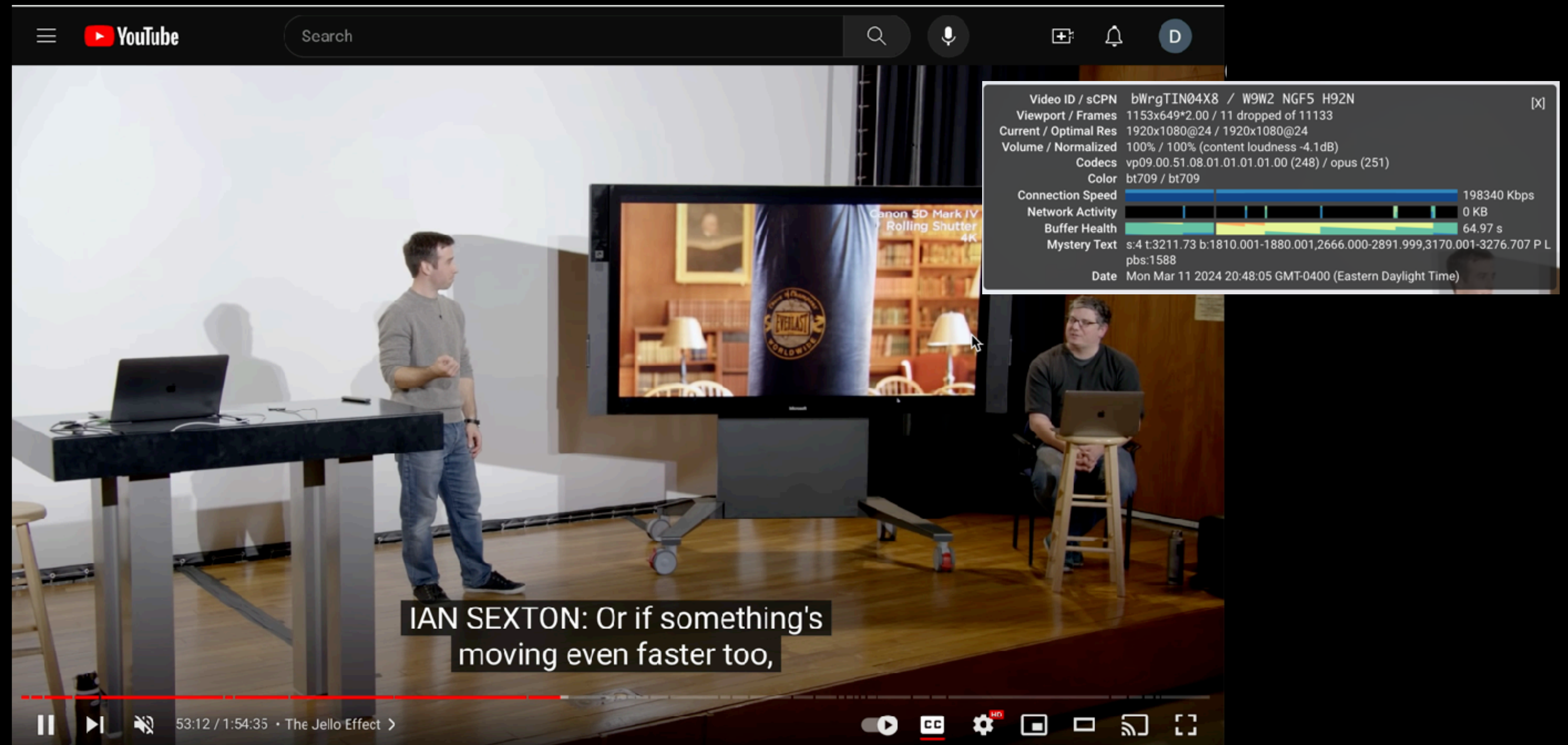


Video Delivery

Adaptive Bitrate



Video Delivery



YouTube Example

Video Delivery



Low views

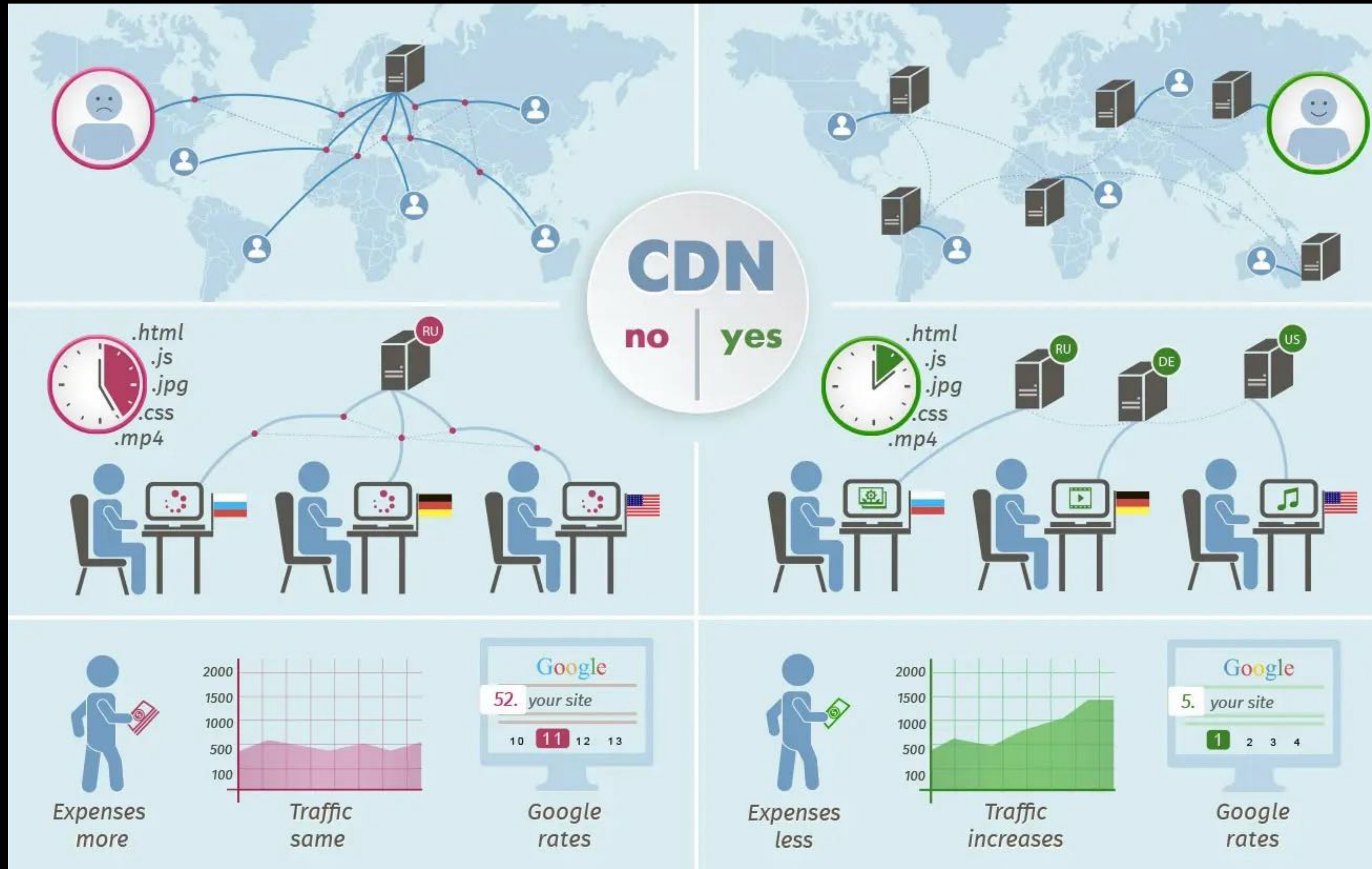
vs



High Views

Video Delivery

Content Delivery Network (CDN)



How To Deliver Your Video

	YOUTUBE	VIMEO	ONLINE VIDEO PLATFORM (BRIGHTCOVE/MUX)	BUILD YOUR OWN
PRICING	FREE	FREE OR SUBSCRIPTION	SUBSCRIPTION	UP TO YOU
COST	NOTHING	LOW COST	MEDIUM COST	HIGH UP-FRONT COSTS (POTENTIALLY) LOWEST HIGH-VOLUME OR LONG-TERM
PROS	FREE, EASY TO TURN ON AD BASED REVENUE	LOW COST, EASY TO CUSTOMIZE	MAINTAIN OWNERSHIP, MORE CONTROL	LOWEST-COST LONG TERM
CONS	LIMITED CONTROL, CONTENT REQUIREMENTS	LIMITATIONS ON MONETIZATION UNLESS YOU USE THEIR MORE EXPENSIVE PLATFORM	HIGHER COST	HARDEST TO DO

High Dynamic Range (HDR) Video

What is HDR, Why?



I hate these "artist's representations"

High Dynamic Range (HDR) Video

What is HDR, Why?

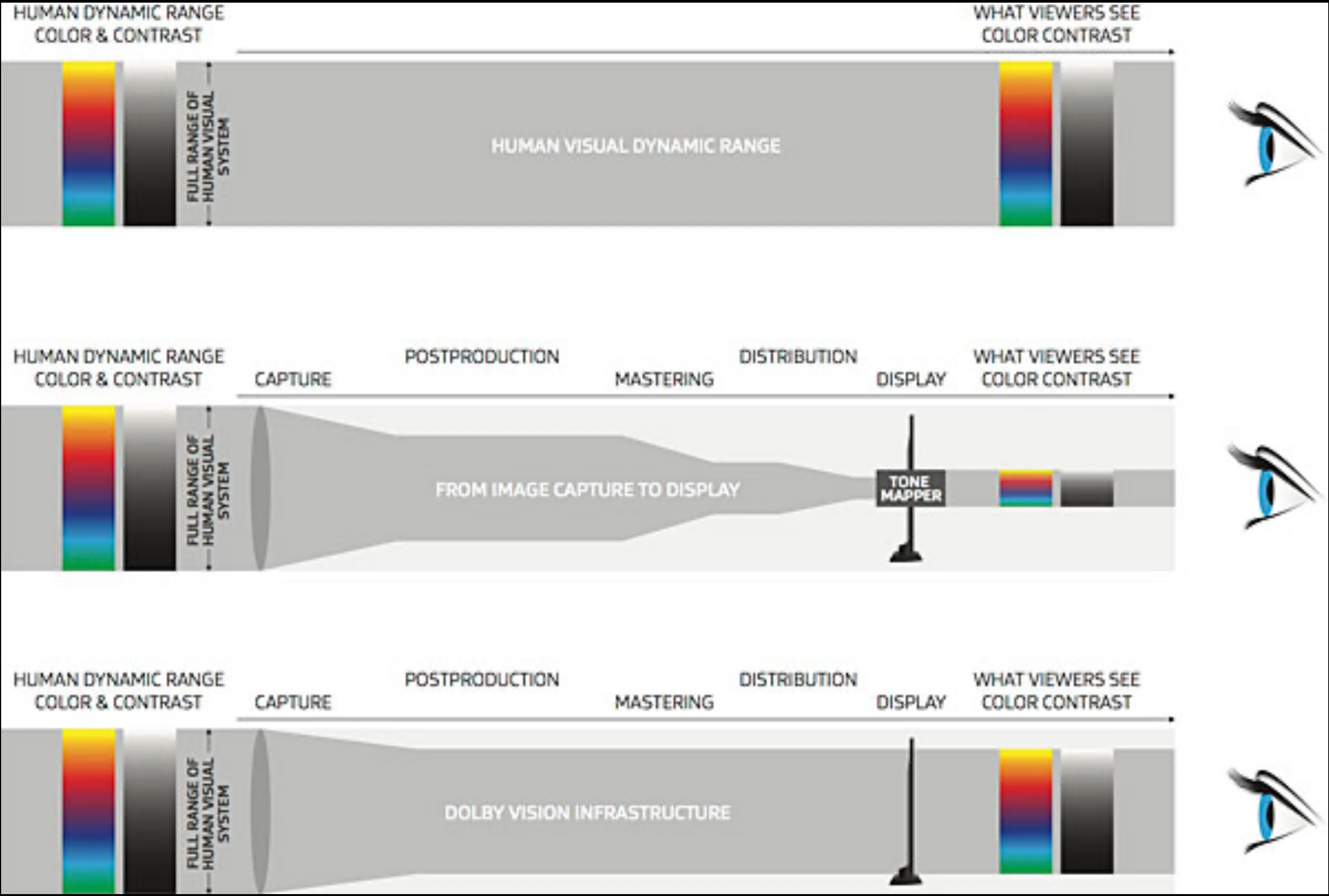
SDR image



HDR image

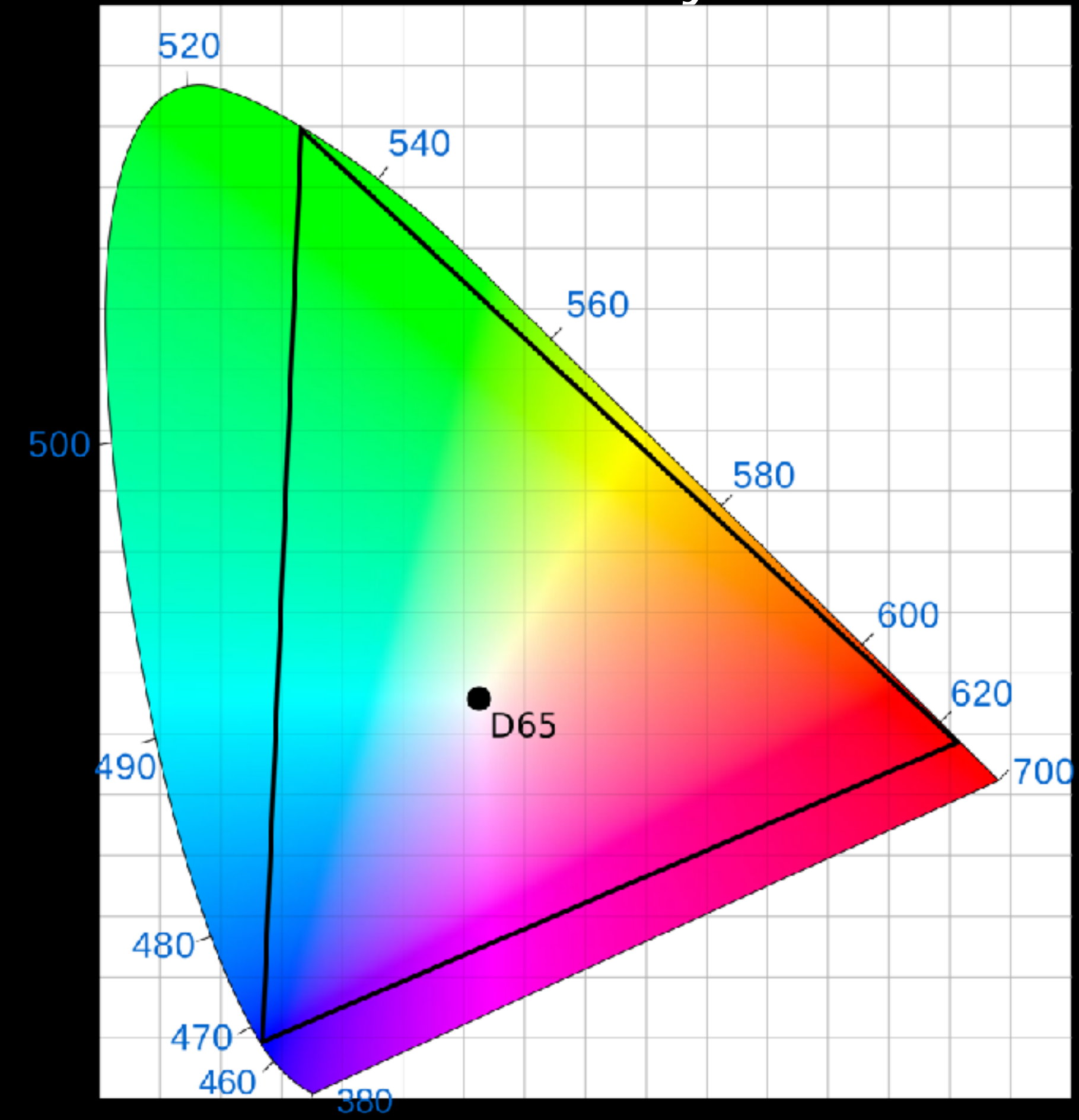


High Dynamic Range (HDR) Video



High Dynamic Range (HDR) Video

What is HDR, Why?



Wide Color Gamut (WCG)



High Dynamic Range (HDR) Video



Flavors of HDR

	METADATA	COMPATIBILITY / ADOPTION	BENEFITS
	STATIC PER VIDEO	HIGHEST	ADOPTION
	DYNAMIC	LOW	"BETTER HDR"
	DYNAMIC	HIGH	"BETTER HDR"
HLG	STATIC	MODERATE	BROADCAST COMPATIBILITY

Making HDR

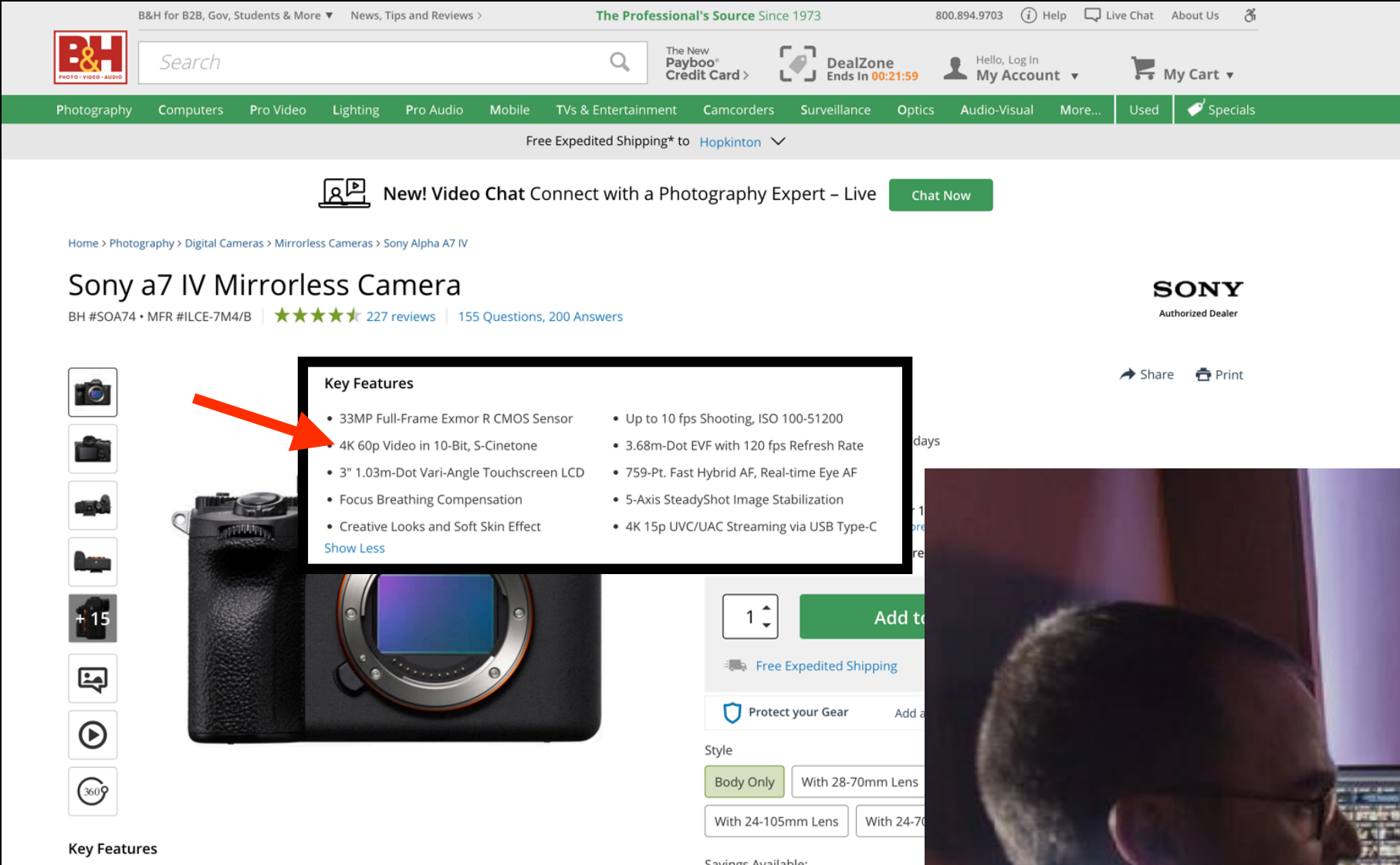


Image from [b&h](#)

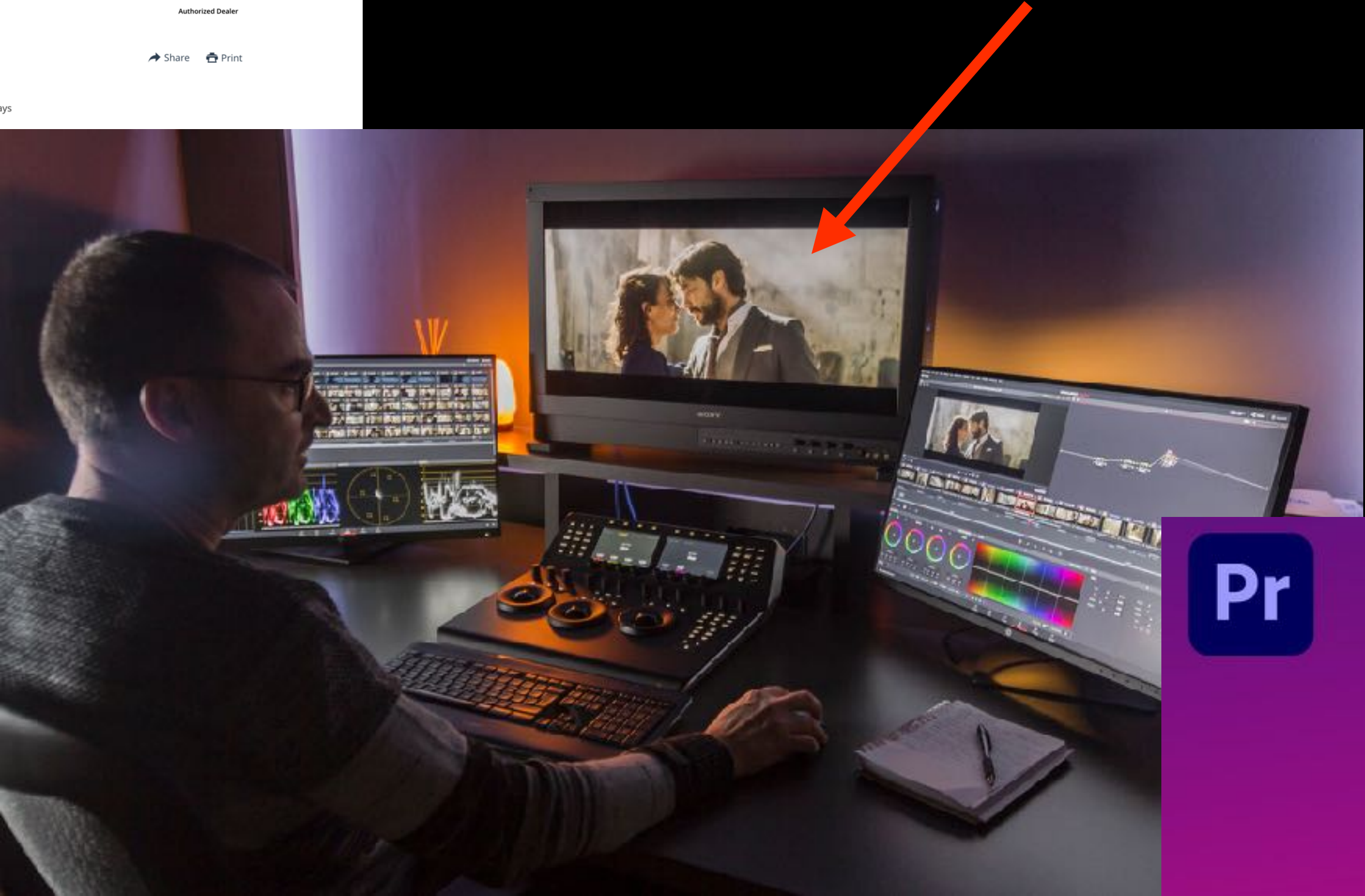


Image from <https://www.studiodaily.com>



Image from <https://www.youtube.com/>

Making HDR



HDR display
Dolby Vision and HDR10
One million-to-one contrast ratio
Color accuracy
3D Touch
True Tone display



< CameraRecord Video

1080p HD at 30 tps

1080p HD at 60 fps

4K at 24 fps

4K at 30 fps ✓

4K at 60 fps

QuickTake video will always record with 1080p HD at 30 fps.

A minute of video will be approximately:

- 45 MB with 720p HD at 30 fps (space saver)
- 65 MB with 1080p HD at 30 fps (default)
- 100 MB with 1080p HD at 60 fps (smoother)
- 150 MB with 4K at 24 fps (film style)
- 190 MB with 4K at 30 fps (higher resolution)
- 440 MB with 4K at 60 fps (higher resolution, smoother)

HDR Video

☒

Record up to 60 fps video in 10-bit high dynamic range including Dolby Vision.

Auto FPS

Auto 30 fps >

Automatically reduce the frame rate to improve low light video and to optimize file size.

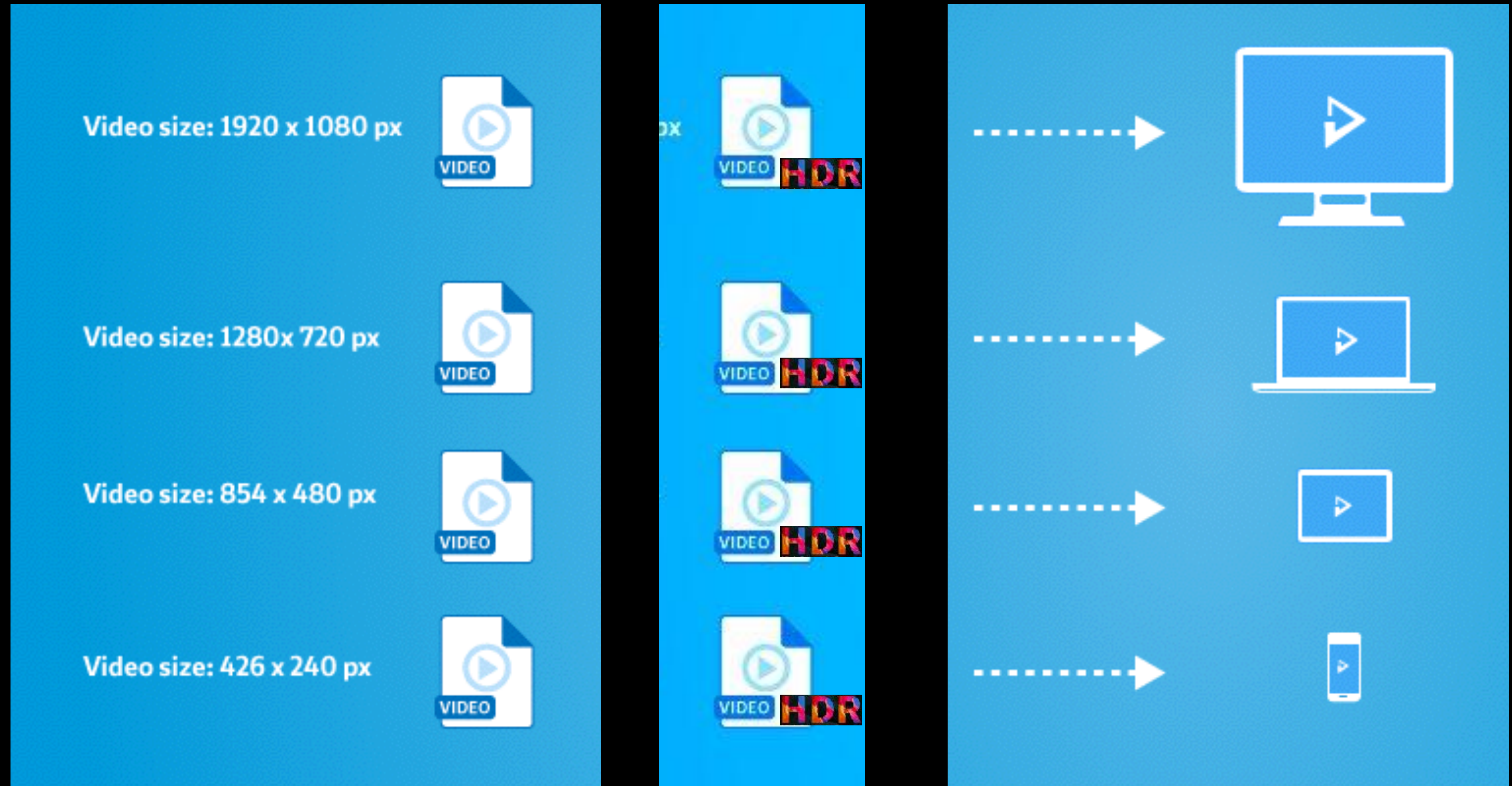
Lock Camera

☐

Do not automatically switch between cameras while recording video.

Distributing and Playing HDR

Adaptive Bitrate



HDR Takeaways

Capture in as high a quality as you can afford
Making HDR depends on your camera/monitor!
HDR adoption is growing
This is a complicated world that will get easier

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