

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

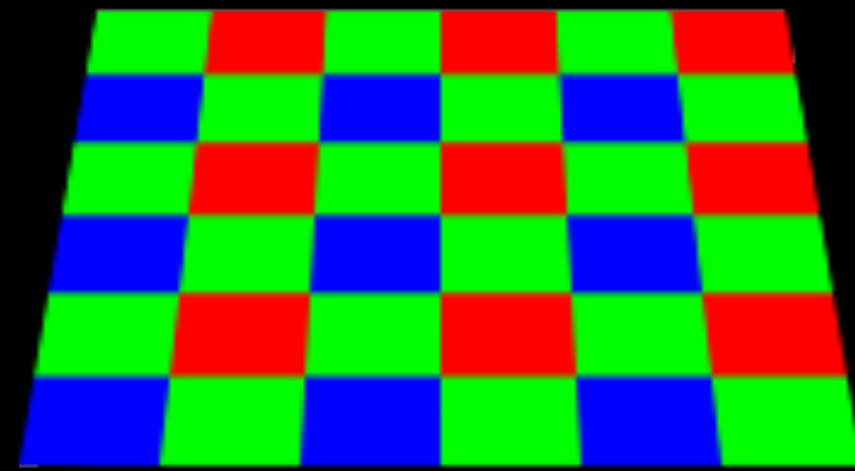
- 1080 P 60 1920x1080; 60p
- 1080 P 30 1920x1080; 30p
- 1080 P 24 1920x1080; 24p
- 720 P 60 1280x 720; 60p
- 424 P 30 640x 424; 30p

Nikon

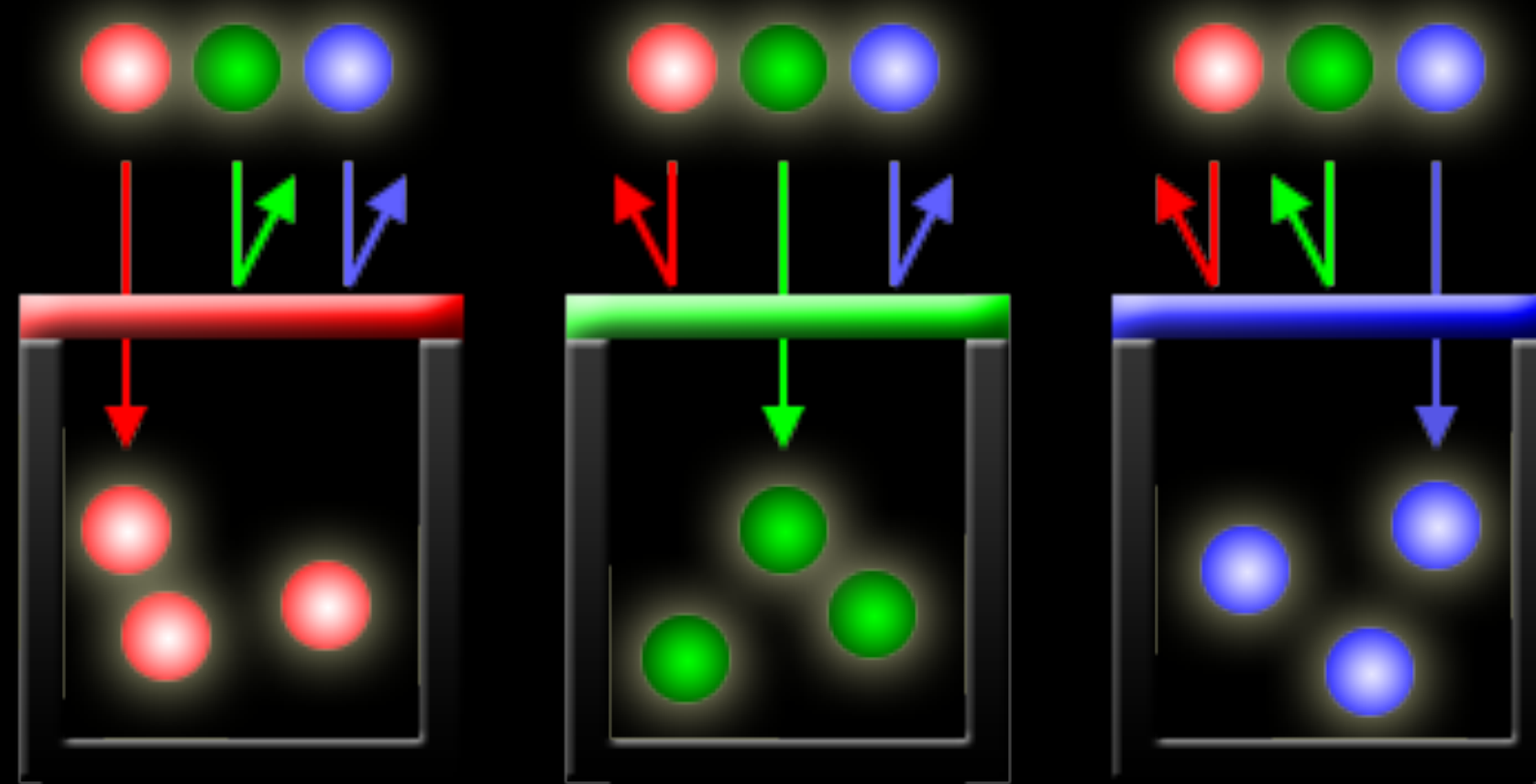


# What the Camera Captures

## Color Sensors (digital)



Bayer Pattern



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



What are the components of video 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)

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

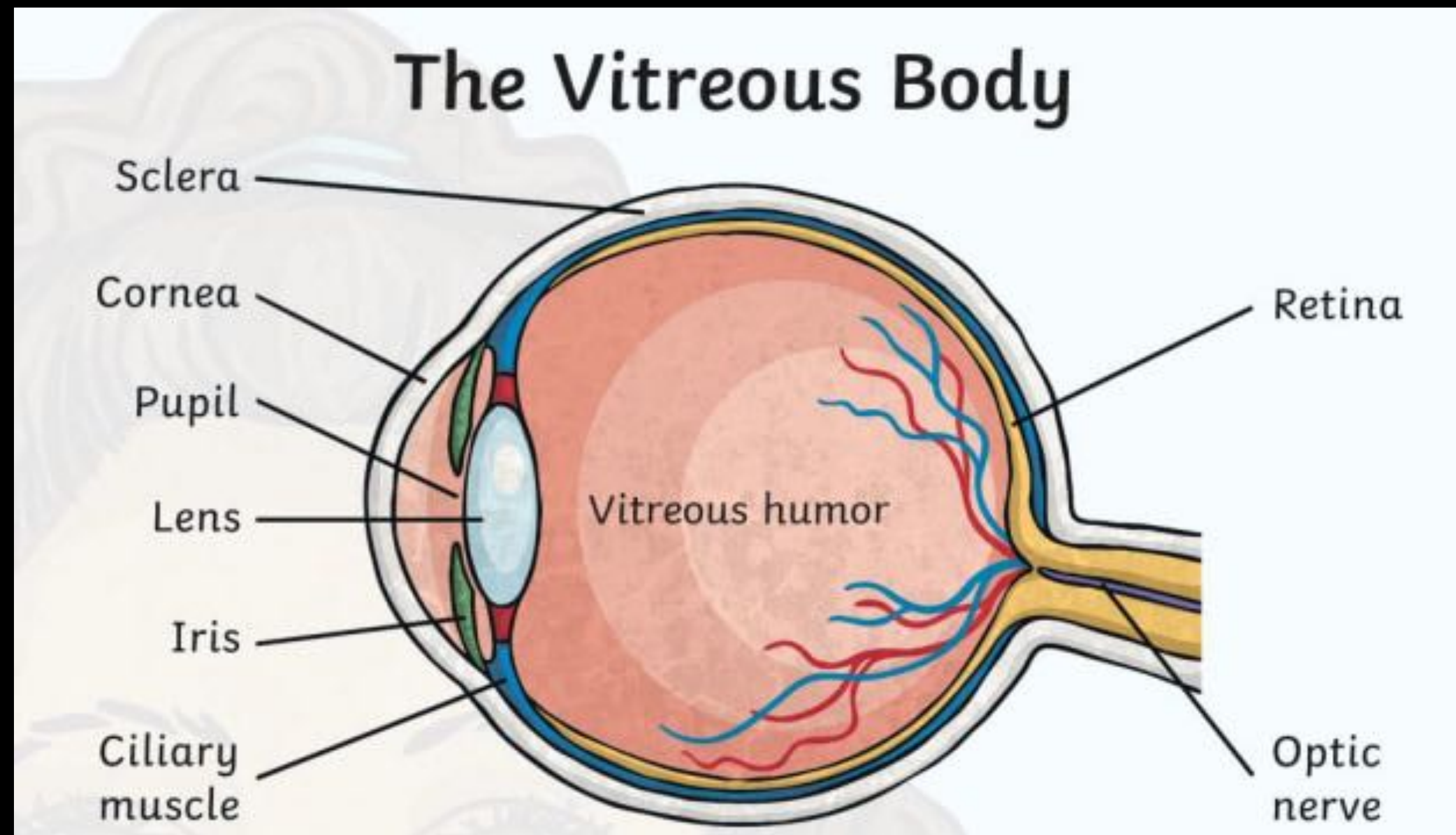
UNCOMPRESSED VIDEO	Bit Depth	Resolution	Frame rate	Total bitrate	5 minutes of video
720p@30 8-bit	8 (*3)	1280x720	30	663 Mbps	24.86 GB
1080p@60 10-bit	10 (*3)	1920x1080	60	3.73 Gbps	140 GB
4K UHD@60 12-bit	12 (*3)	3840x2160	60	17.91 Gbps	671 GB
8K UHD@60 12-bit	12(*3)	7680 × 4320	60	71.6 Gbps	2.7 TB

How Big is all of this Data?

TOO BIG



# What Do We Do About it?



The Human Visual System is Imperfect

What Do We Do About it?

*Spend more bits here!*



**More Sensitive**

**Less Sensitive**

Brightness (Luma)

Color (Chroma)

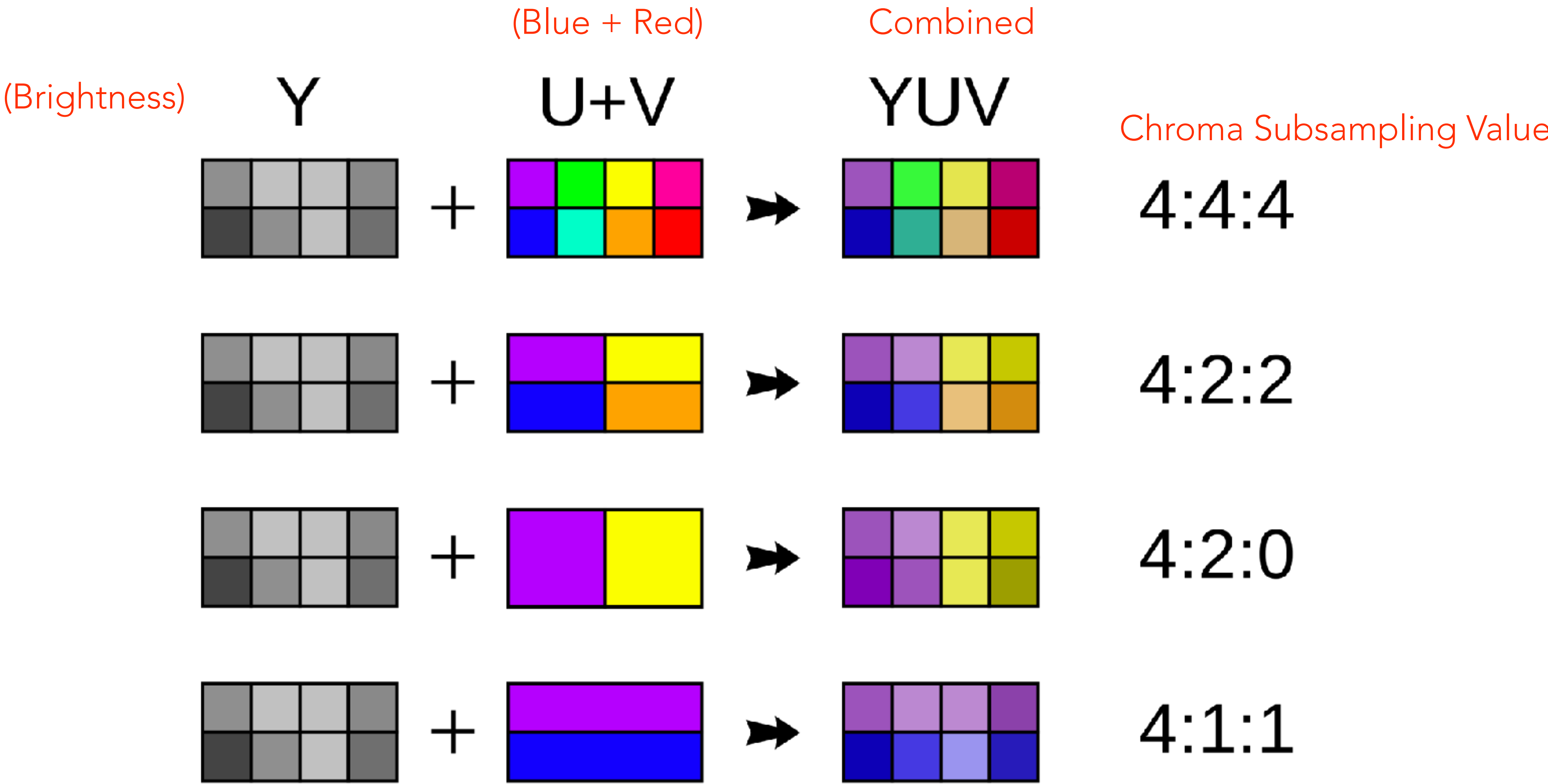
Light Areas

Dark Areas

Lower Frequency Detail

High Frequency Detail

# Chroma Subsampling







WEEK 0: WELCOME

# DIGITAL MEDIA E-5 EXPLORING DIGITAL MEDIA

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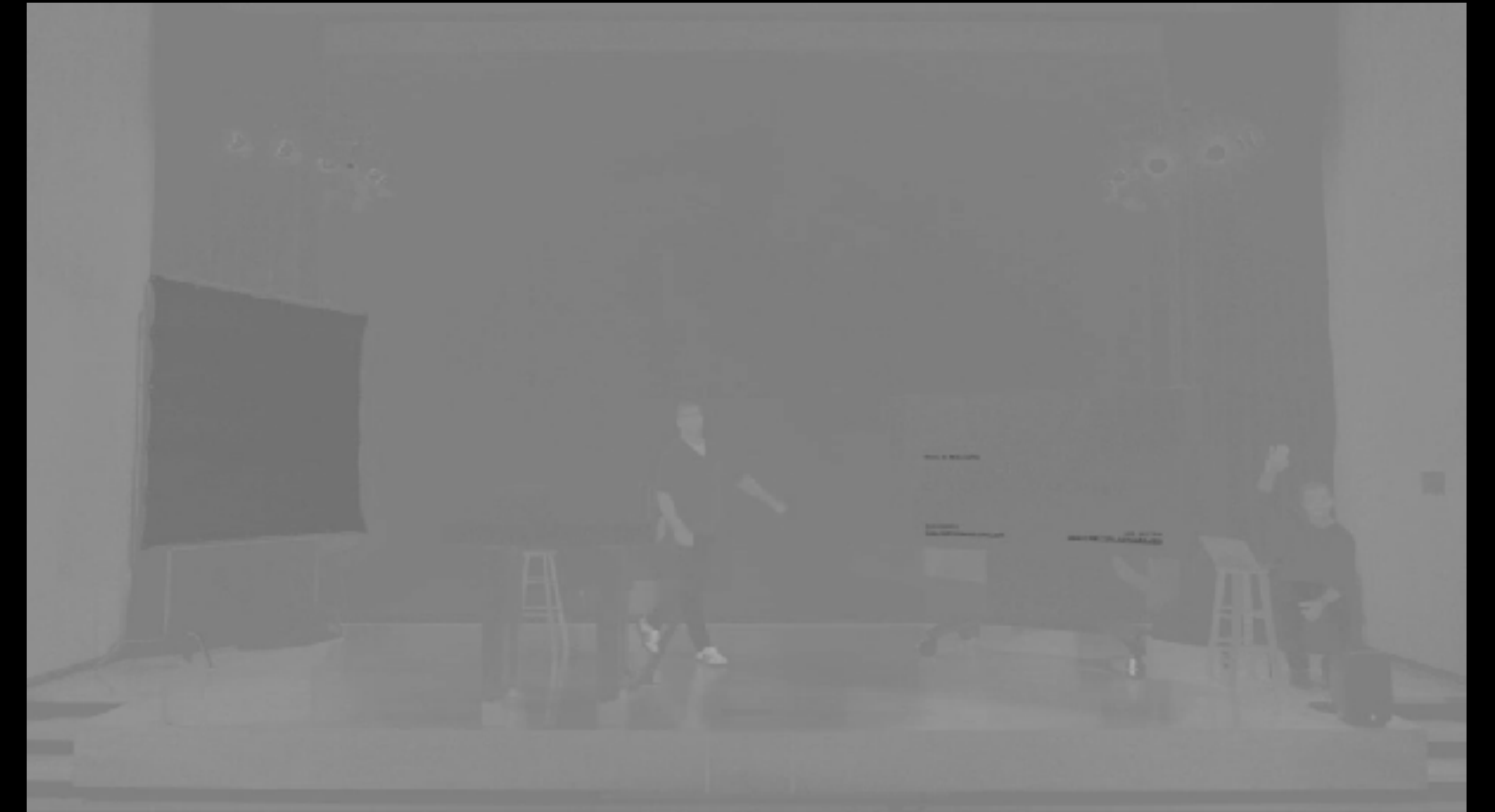


Y (luminance)



4:2:0

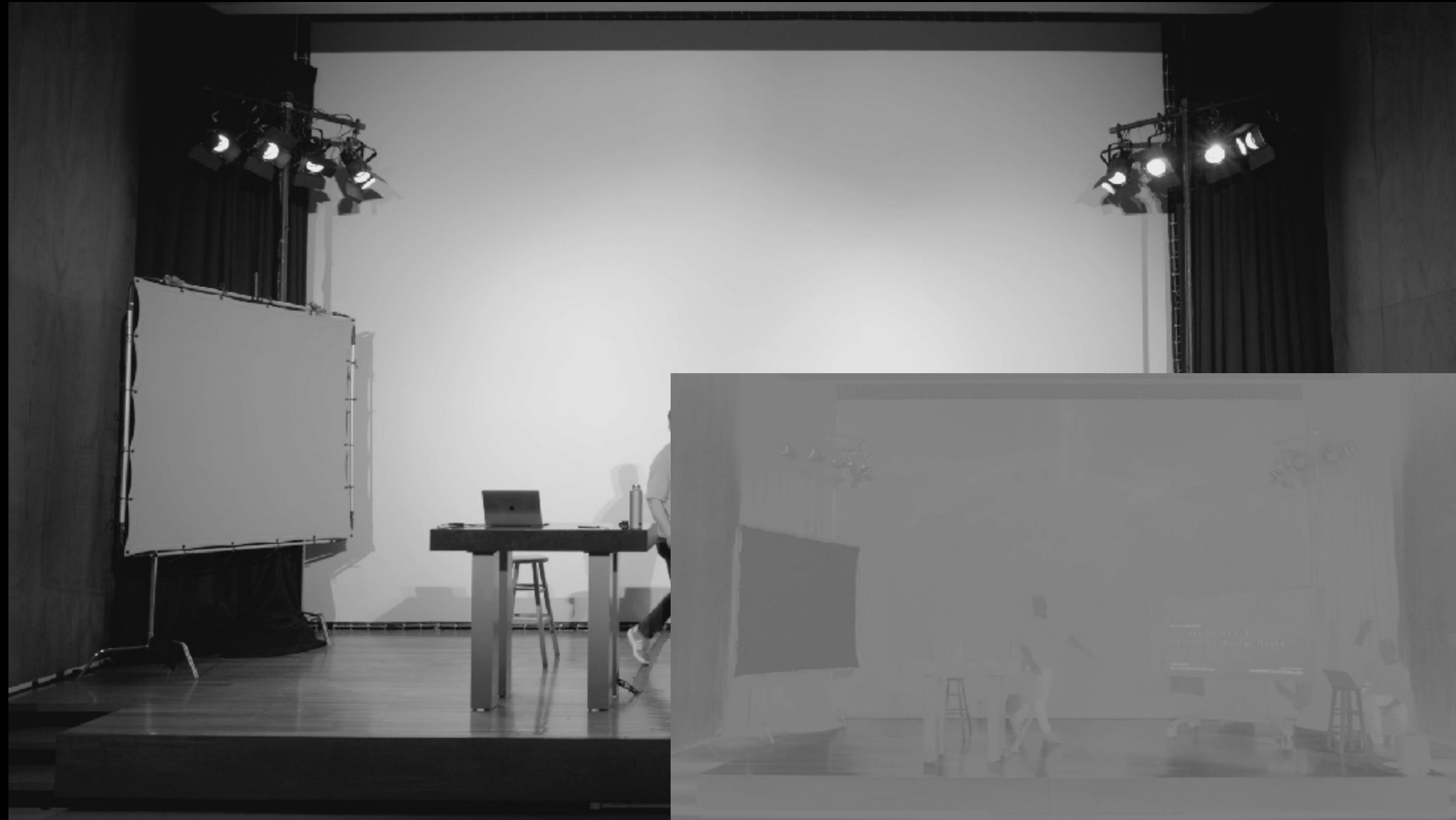
Cb (blue component)



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... ????

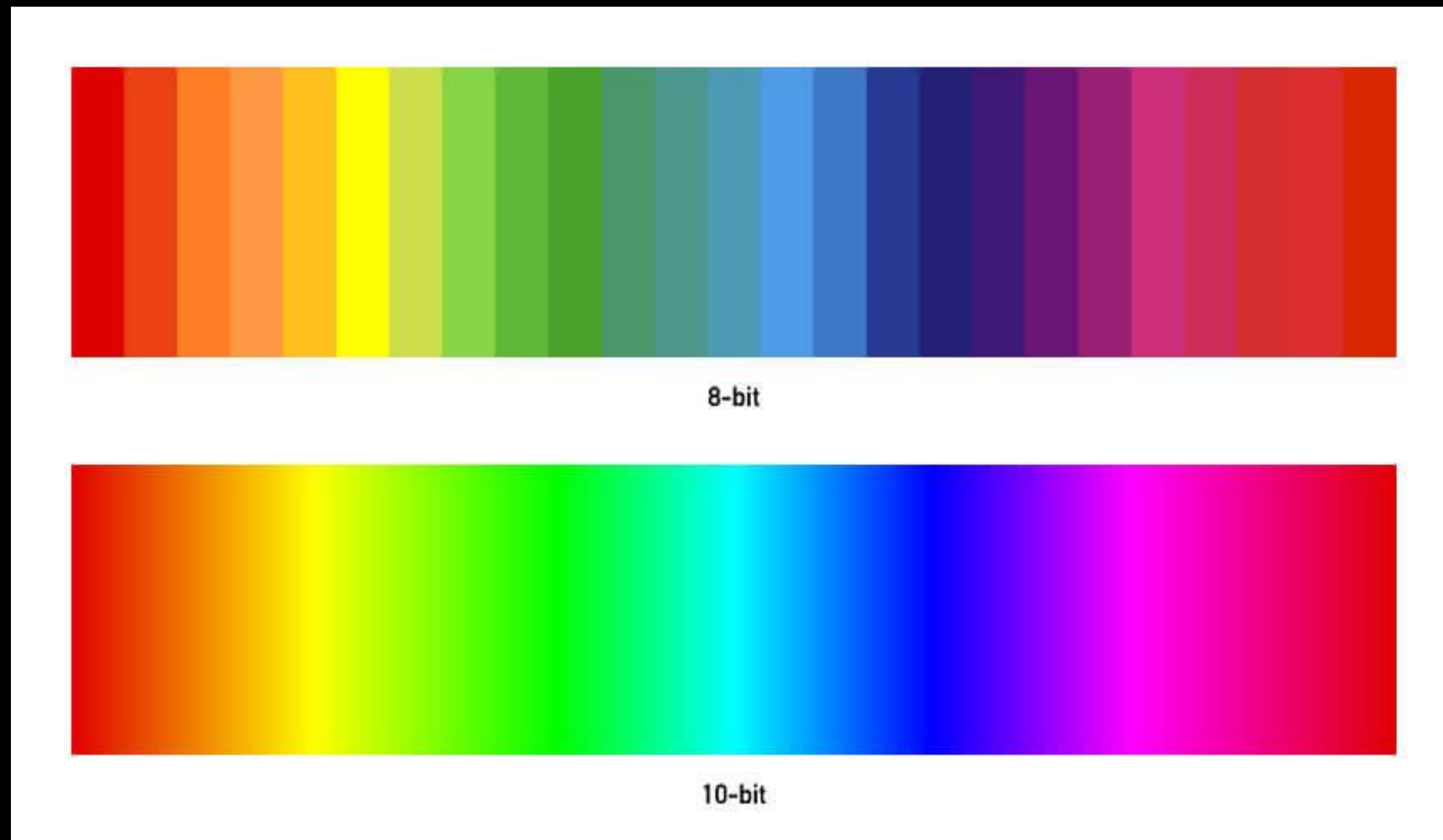
## Binary Representation (base 2)

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

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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

360°

1

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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]

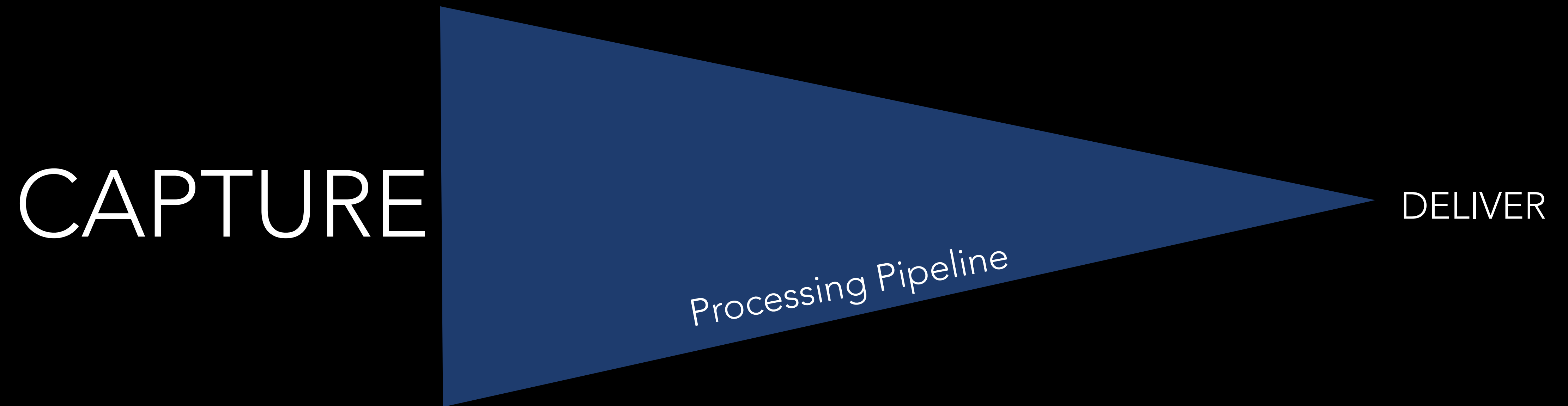
Full HD (1920 x 1080) at

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

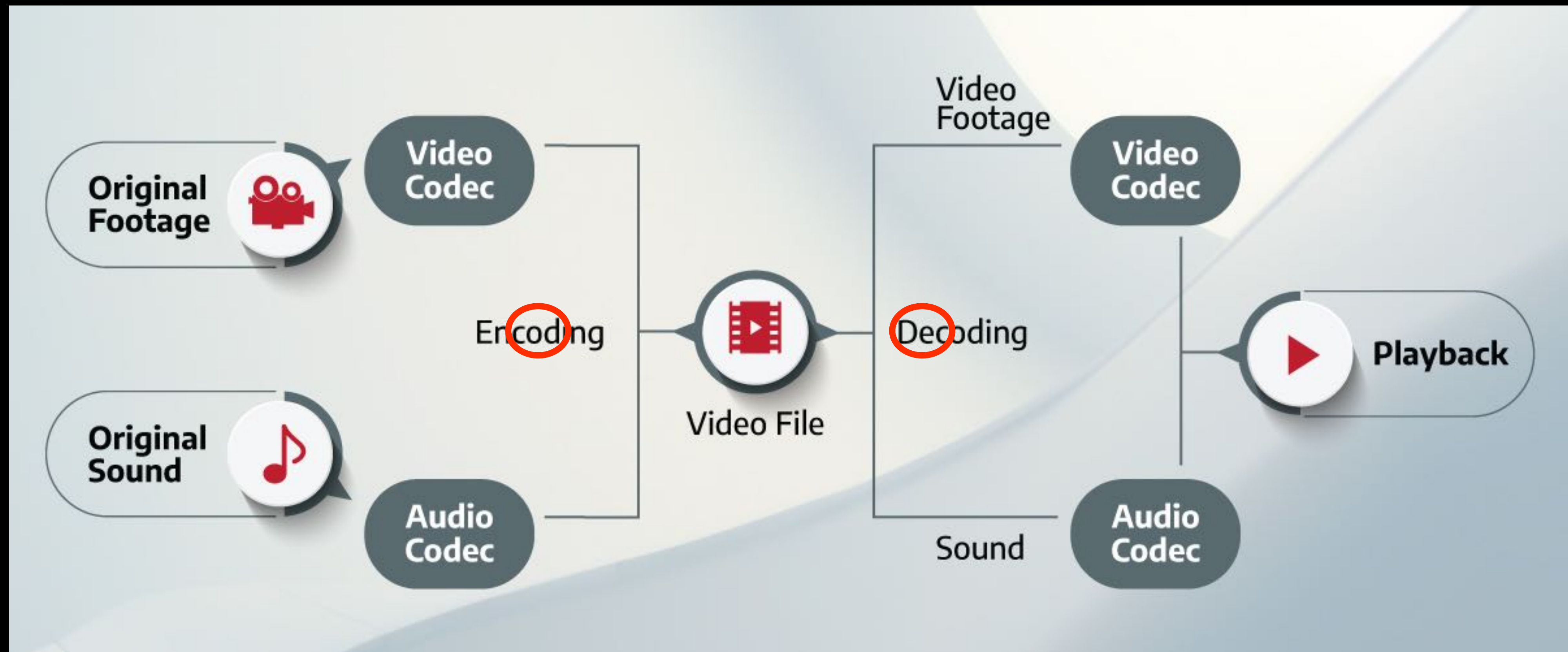


At least 10-bit 422 when possible

depends\*

# Video Compression

## Codec



Encoder Decoder

# Video Compression

# Frames





# Video Compression

# Frames





# Video Compression

Frame Types

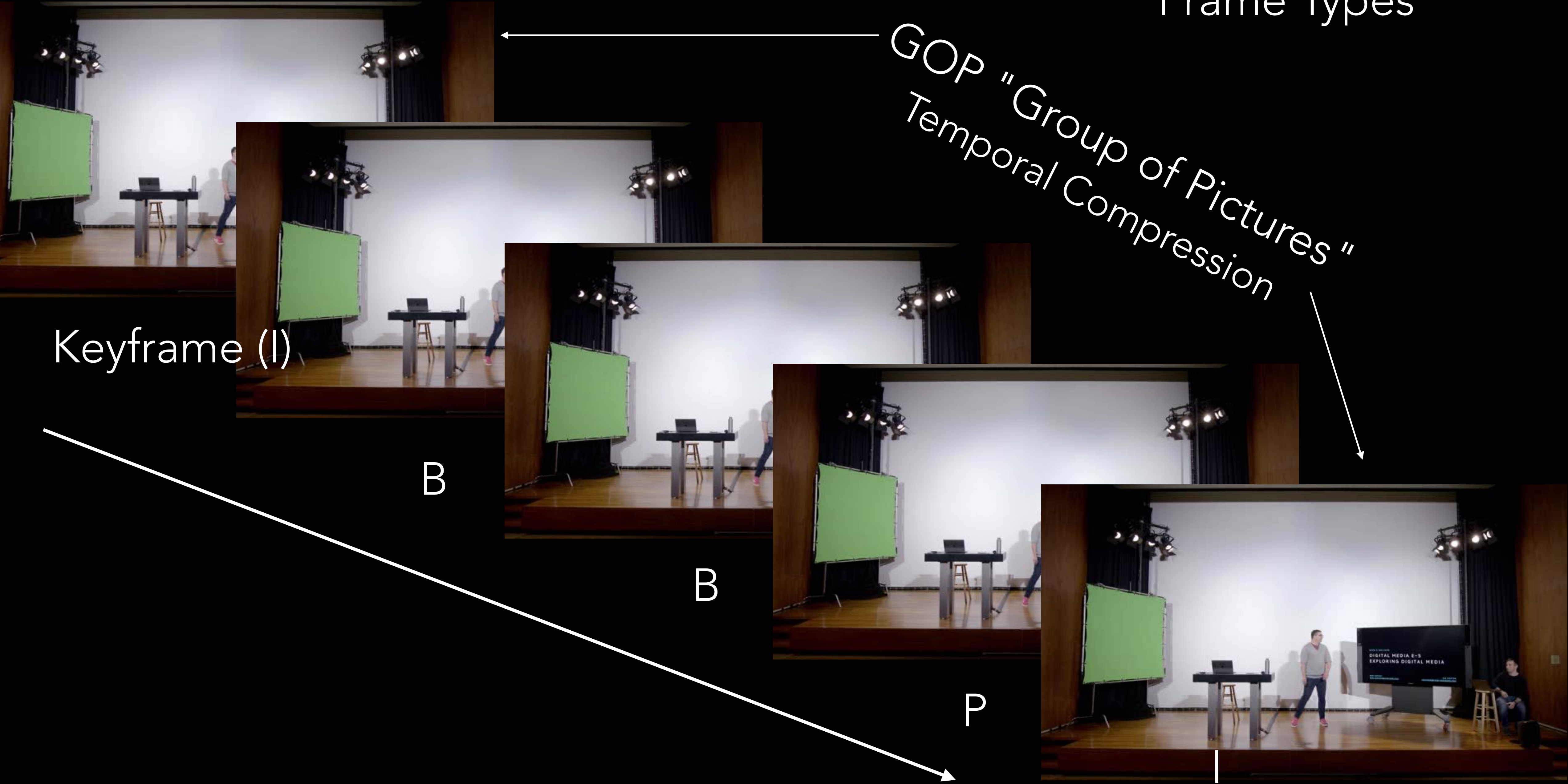
GOP "Group of Pictures"  
Temporal Compression

Keyframe (I)

B

B

P





# Video Compression

# Frames



# Video Compression

my\_file.mp4

Metadata

Video Track (h264 codec)

Audio Track (aac codec)



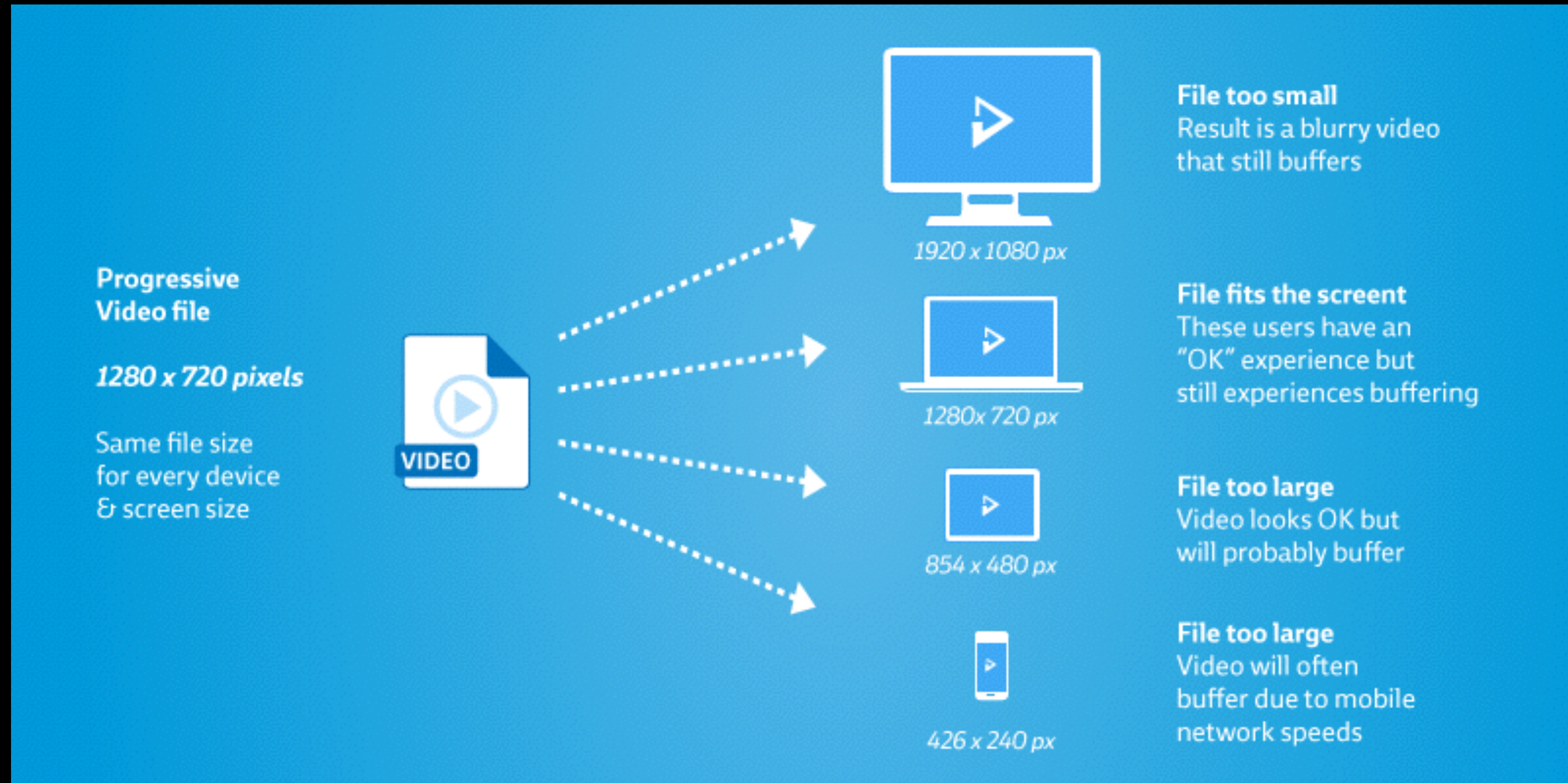
# Video Delivery

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



# Video Delivery

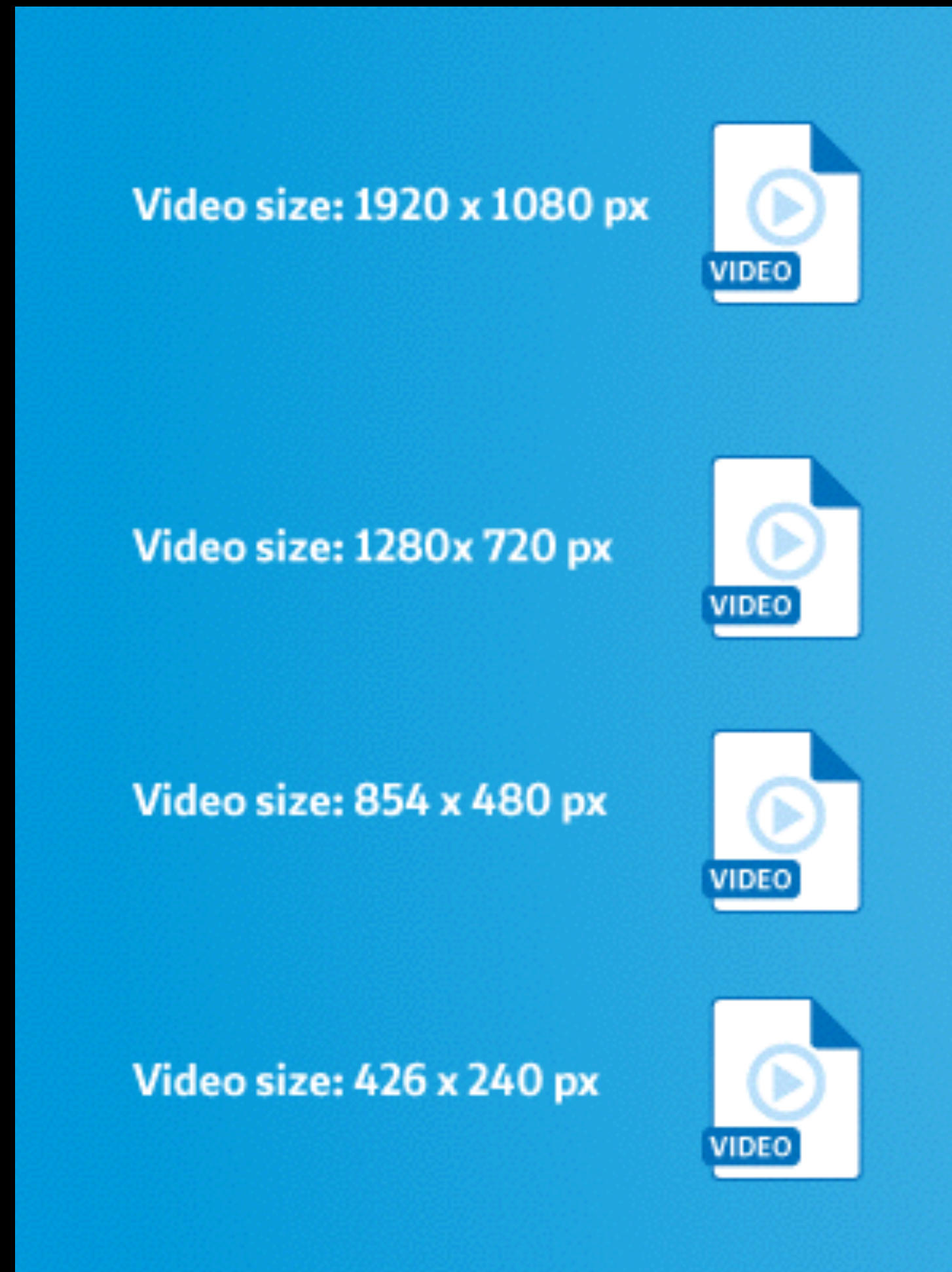
## Single File Approach (progressive download)





# Video Delivery

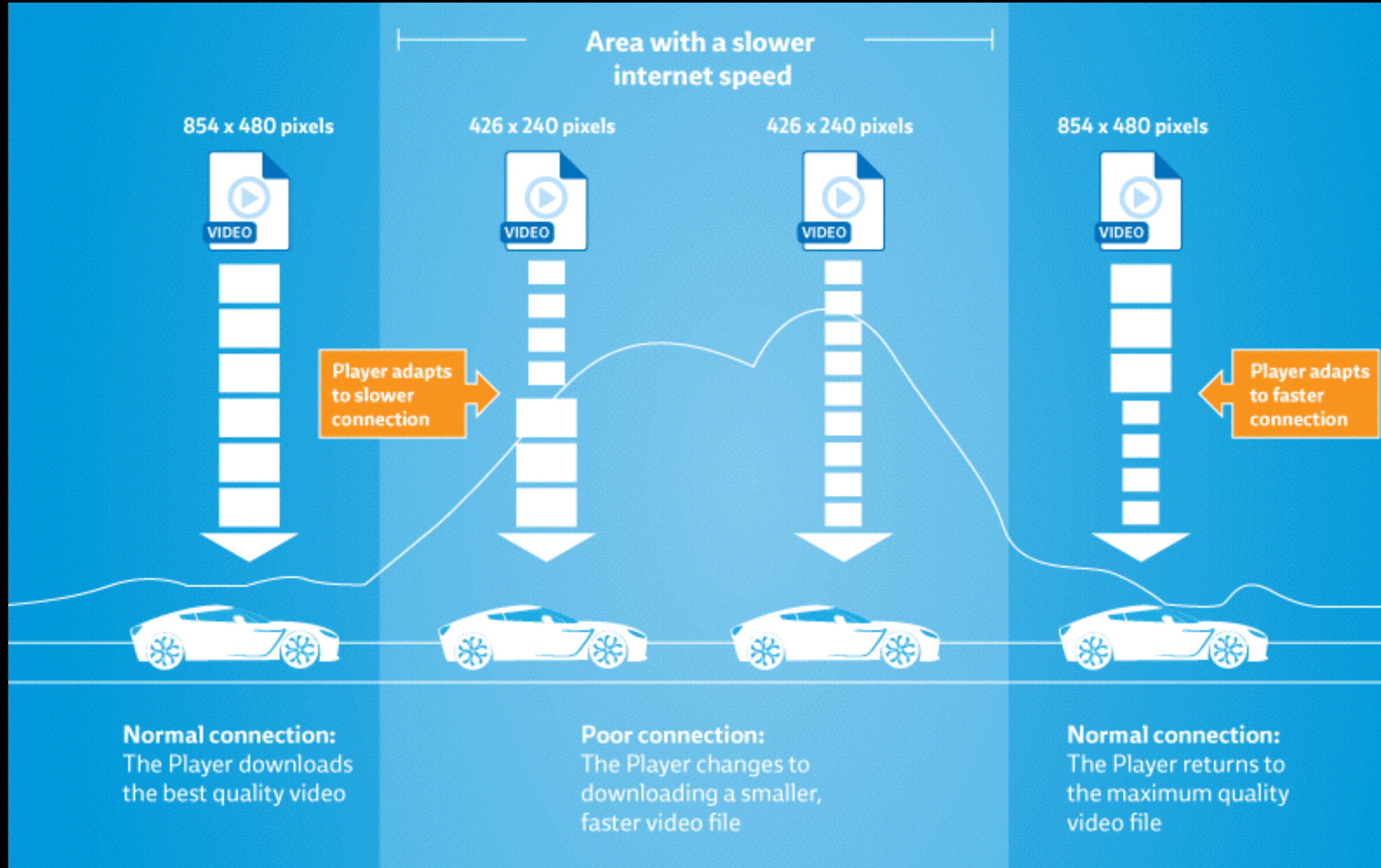
## Adaptive Bitrate





# Video Delivery

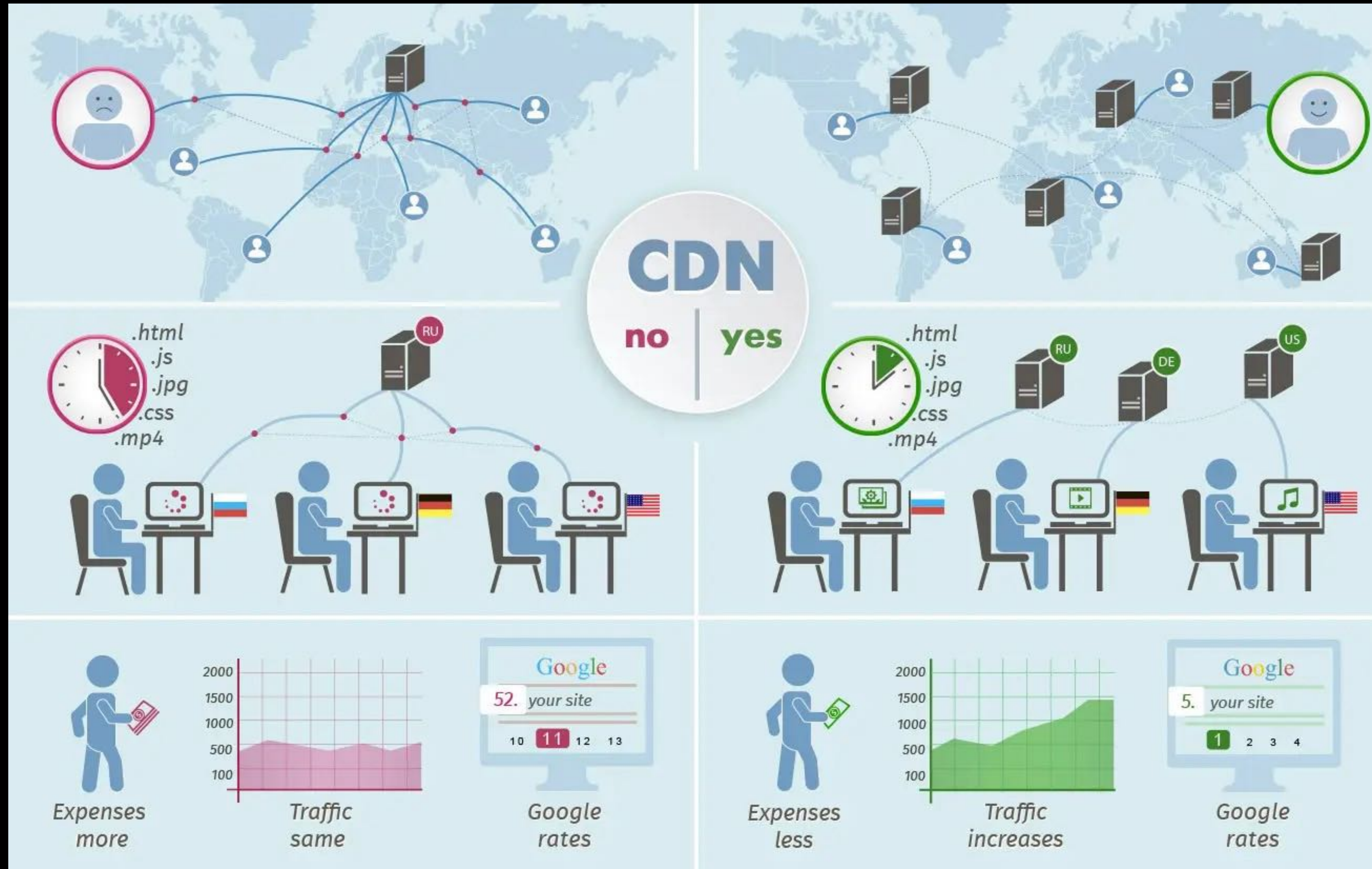
## Adaptive Bitrate





# Video Delivery

## 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?





# High Dynamic Range (HDR) Video

What is HDR, Why?

SDR image

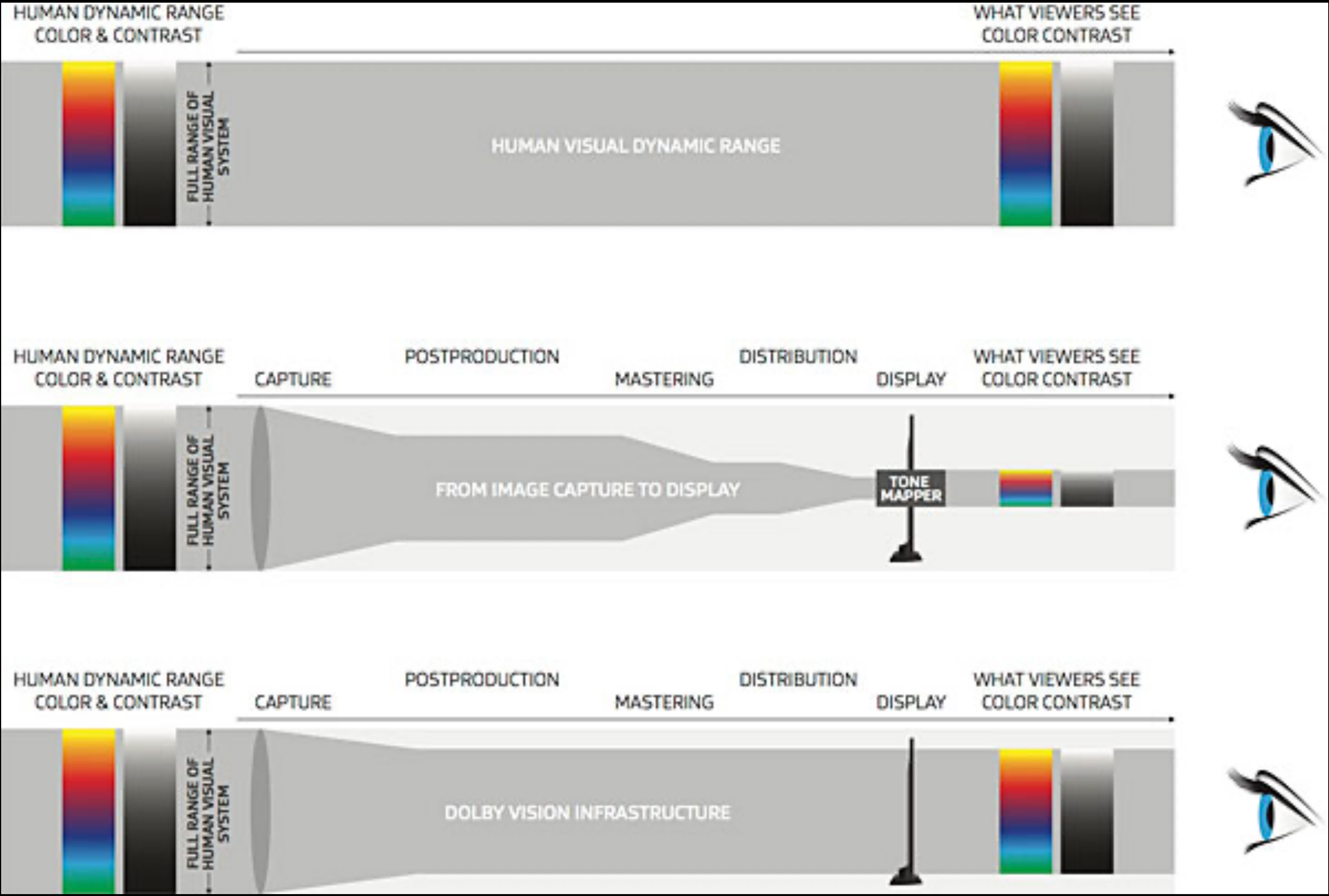


HDR image





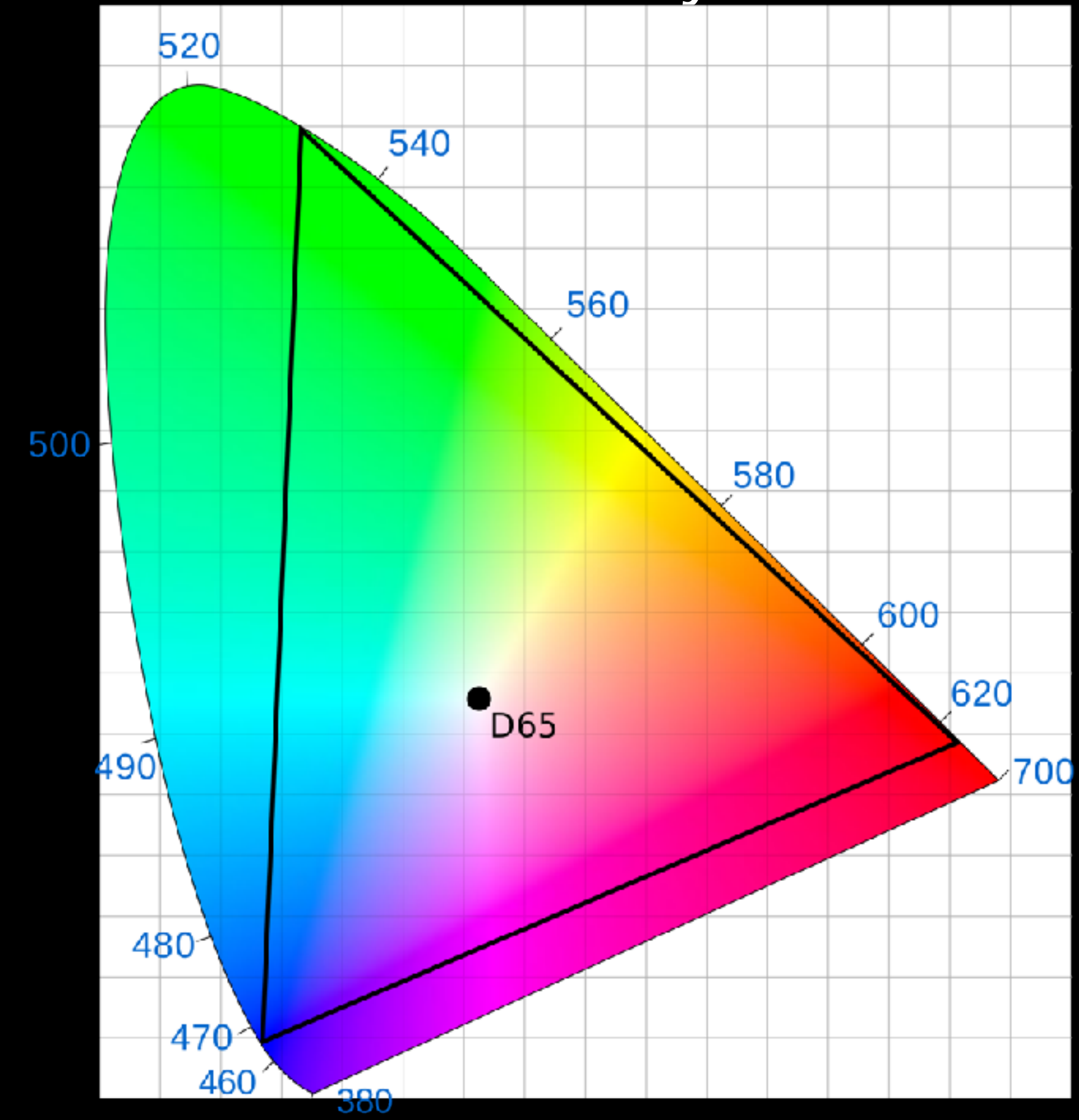
# High Dynamic Range (HDR) Video





# 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

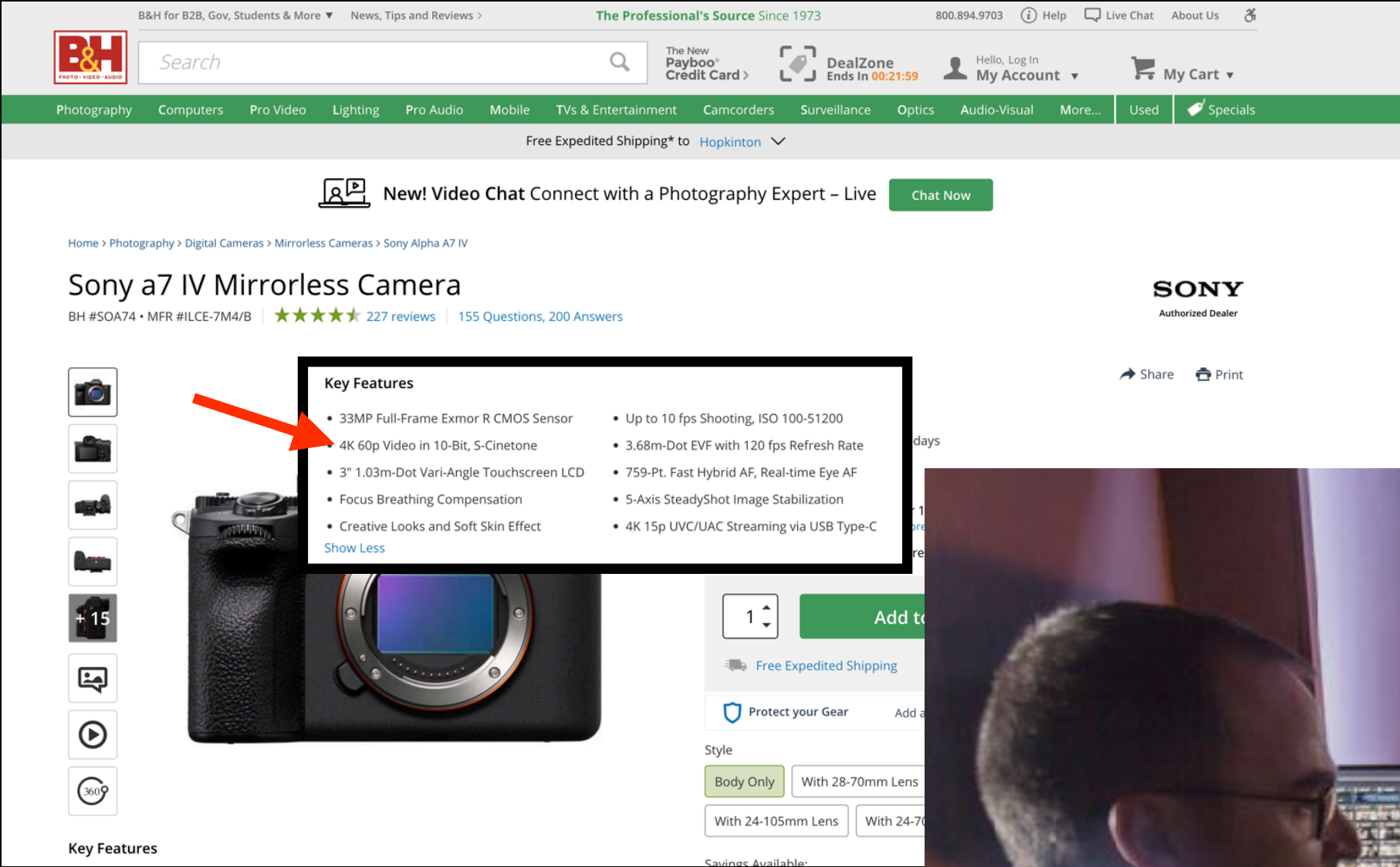


Image from [b&h](https://www.bhphotovideo.com)

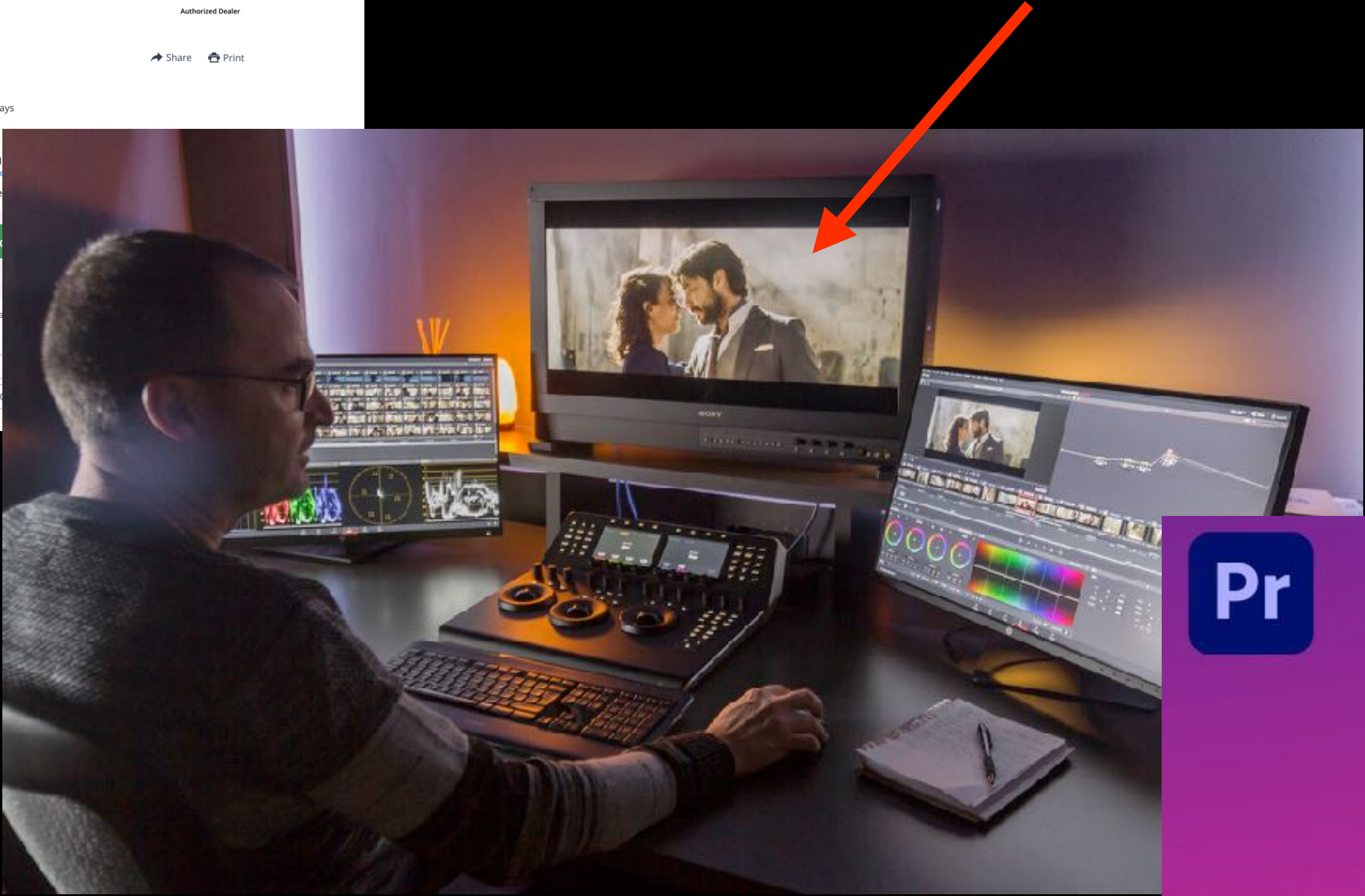


Image from <https://www.studiodaily.com>



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



[← Camera](#) **Record Video**

- 1080p HD at 30 fps
- 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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