

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

XAVCS 4K XAVCS 4K

XAVCS HD XAVCS HD

AVCHD AVCHD

MP4 MP4

Sony

## Movie settings

### Frame size/frame rate

1080P 60 1920x1080; 60p

1080P 30 1920x1080; 30p

1080P 24 1920x1080; 24p

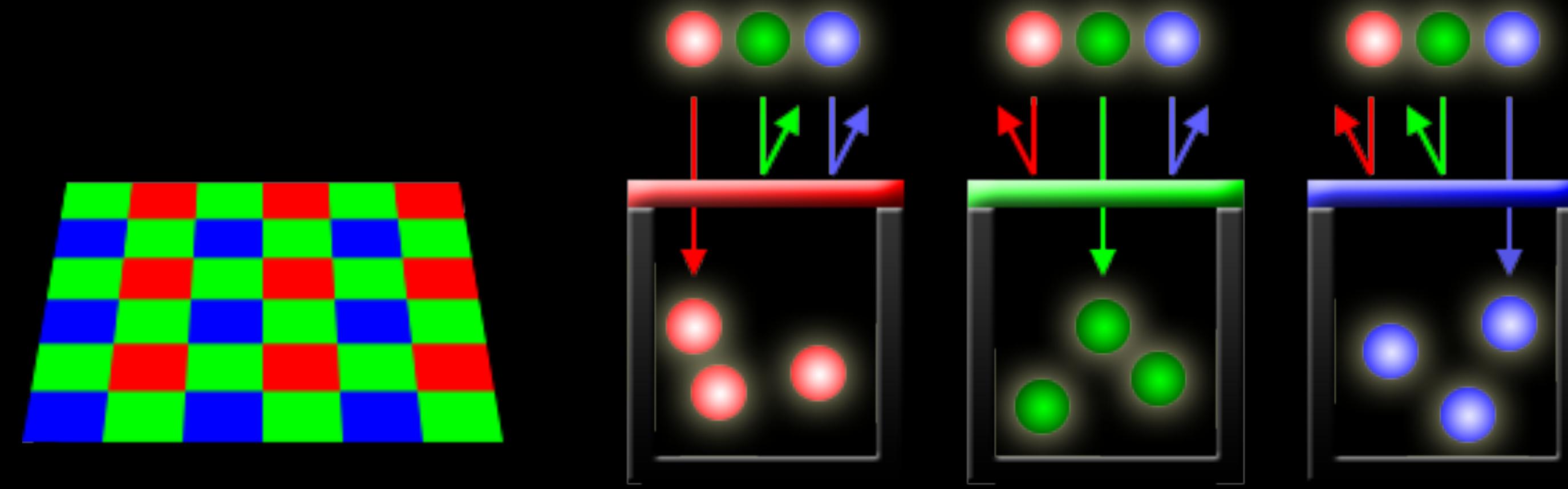
720P 60 1280x 720; 60p

424P 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)

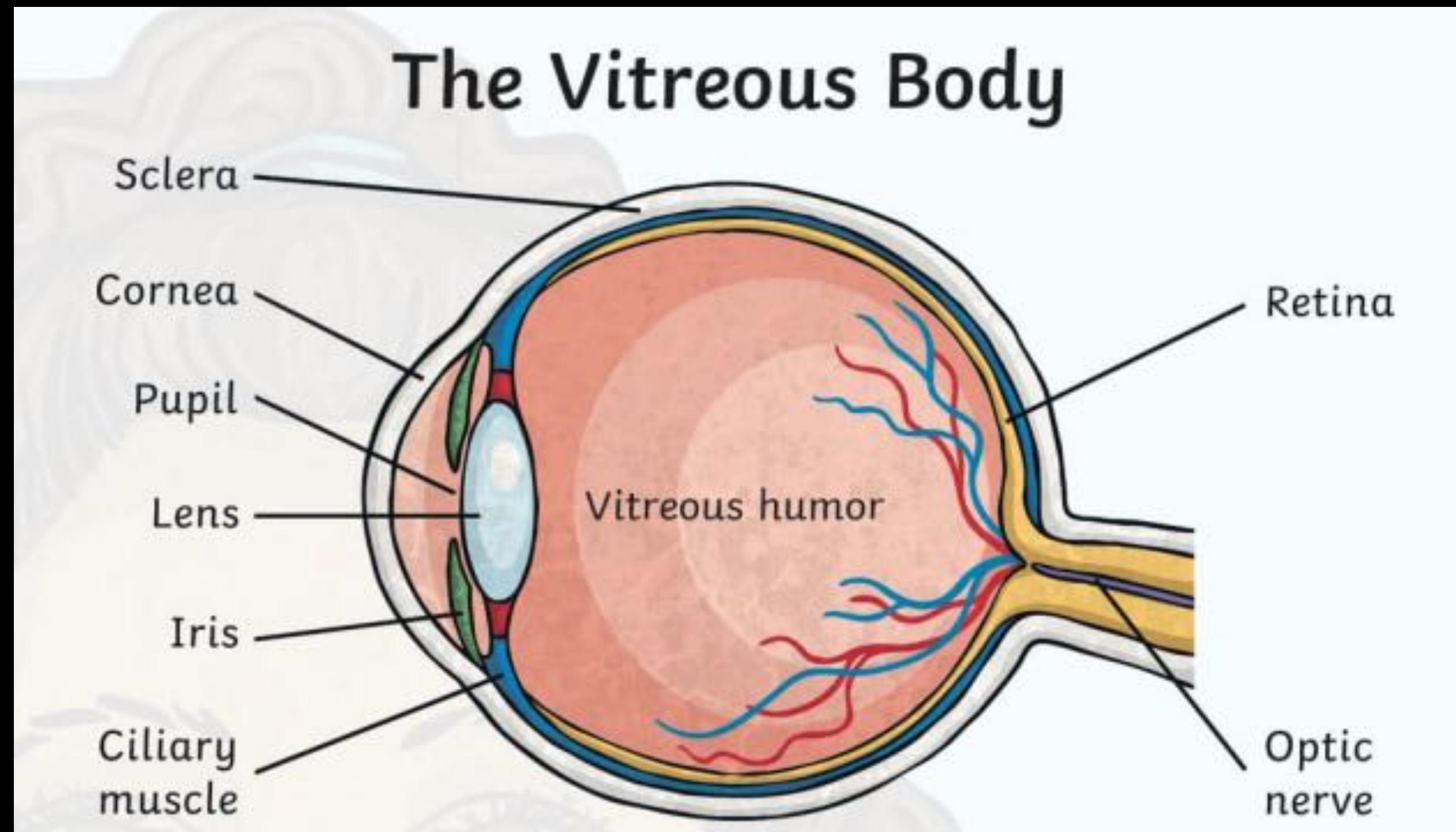
data rate = color depth × vertical resolution × horizontal resolution × refresh frequency

| 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**

Brightness (Luma)

Light Areas

Lower Frequency Detail

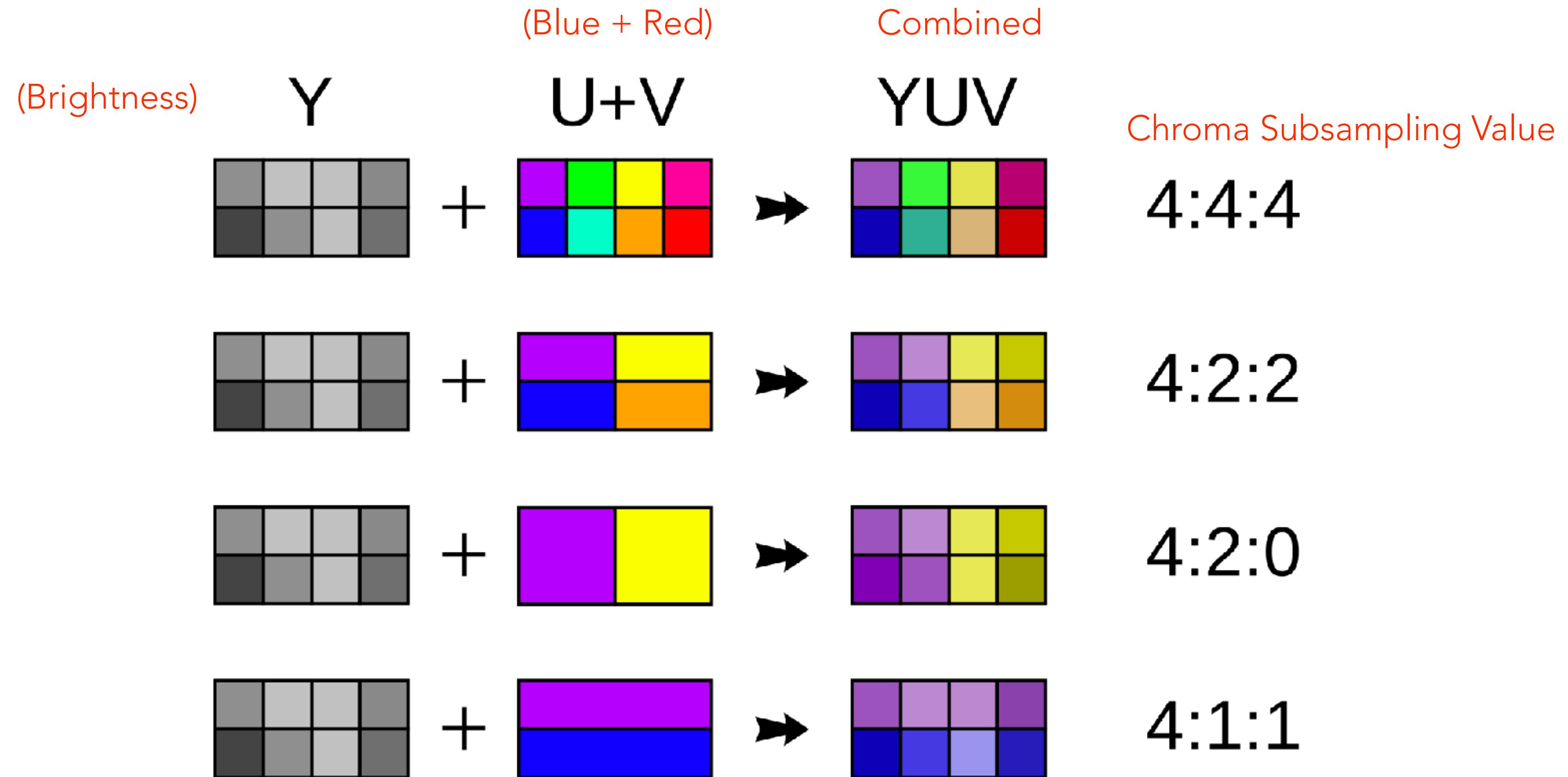
**Less Sensitive**

Color (Chroma)

Dark Areas

High Frequency Detail

# Chroma Subsampling





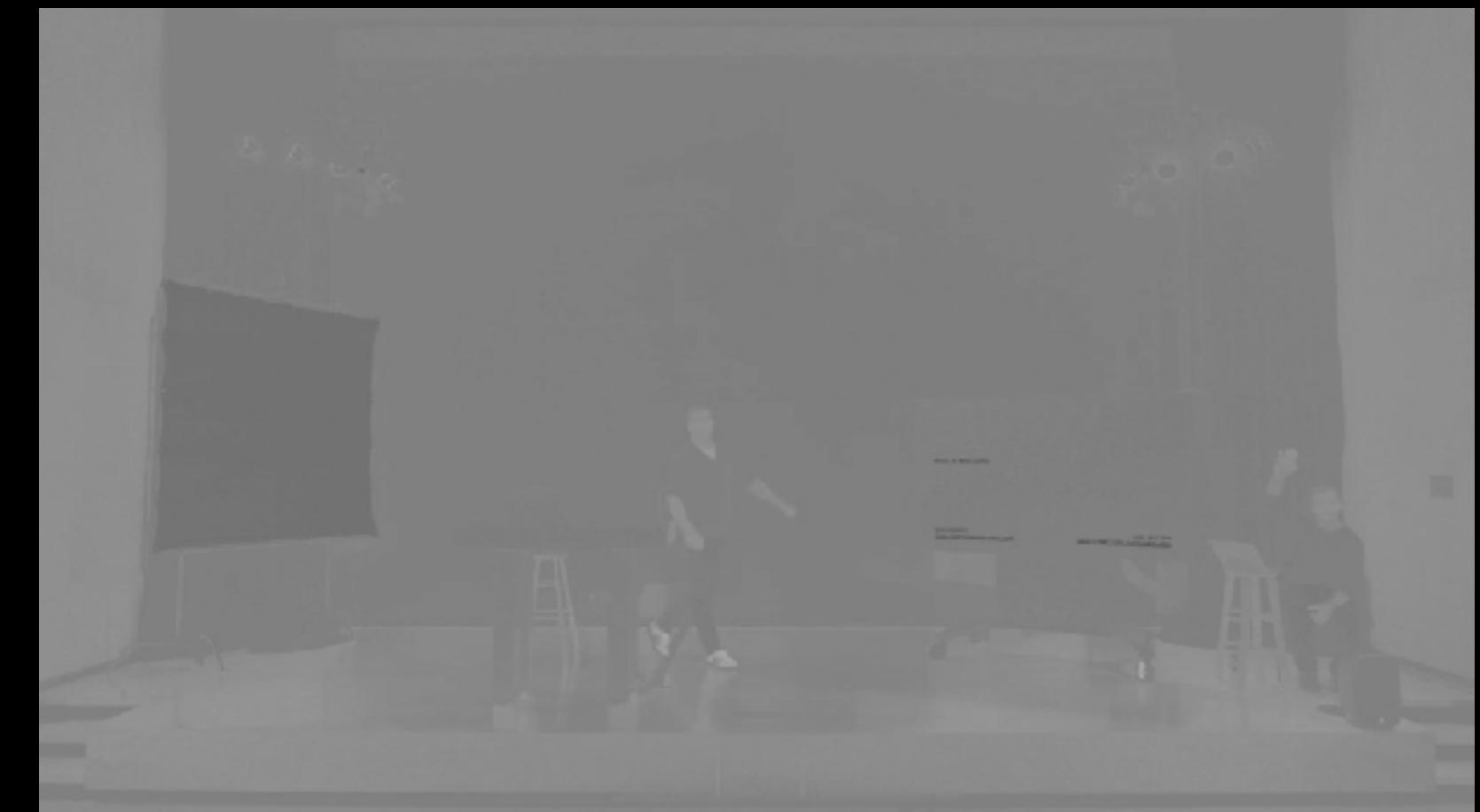
WEEK 0: WELCOME

## DIGITAL MEDIA E-5 EXPLORING DIGITAL MEDIA

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Cb (blue component)



Y (luminance)

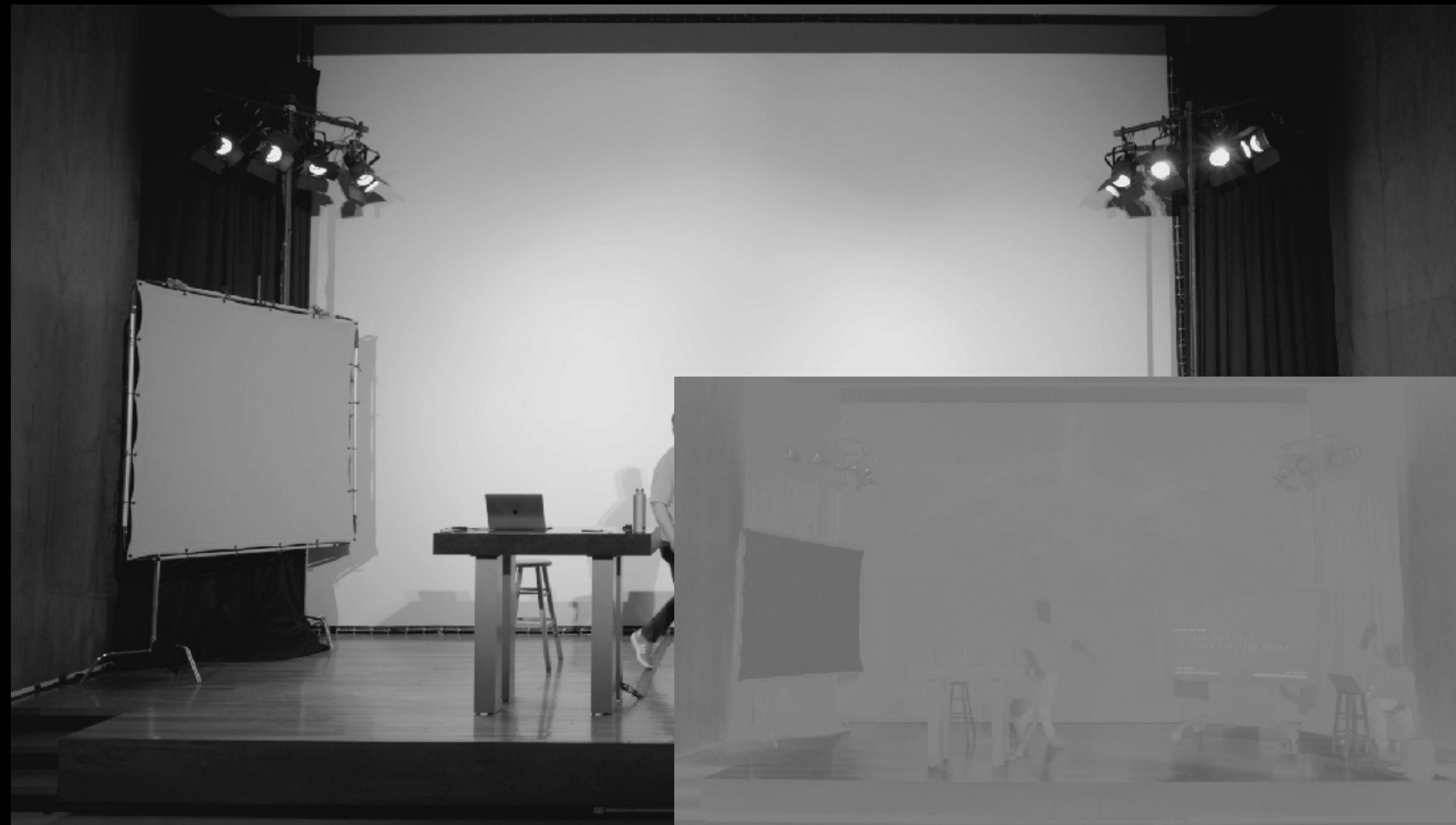


Cr (red component)



4:2:0

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... ???

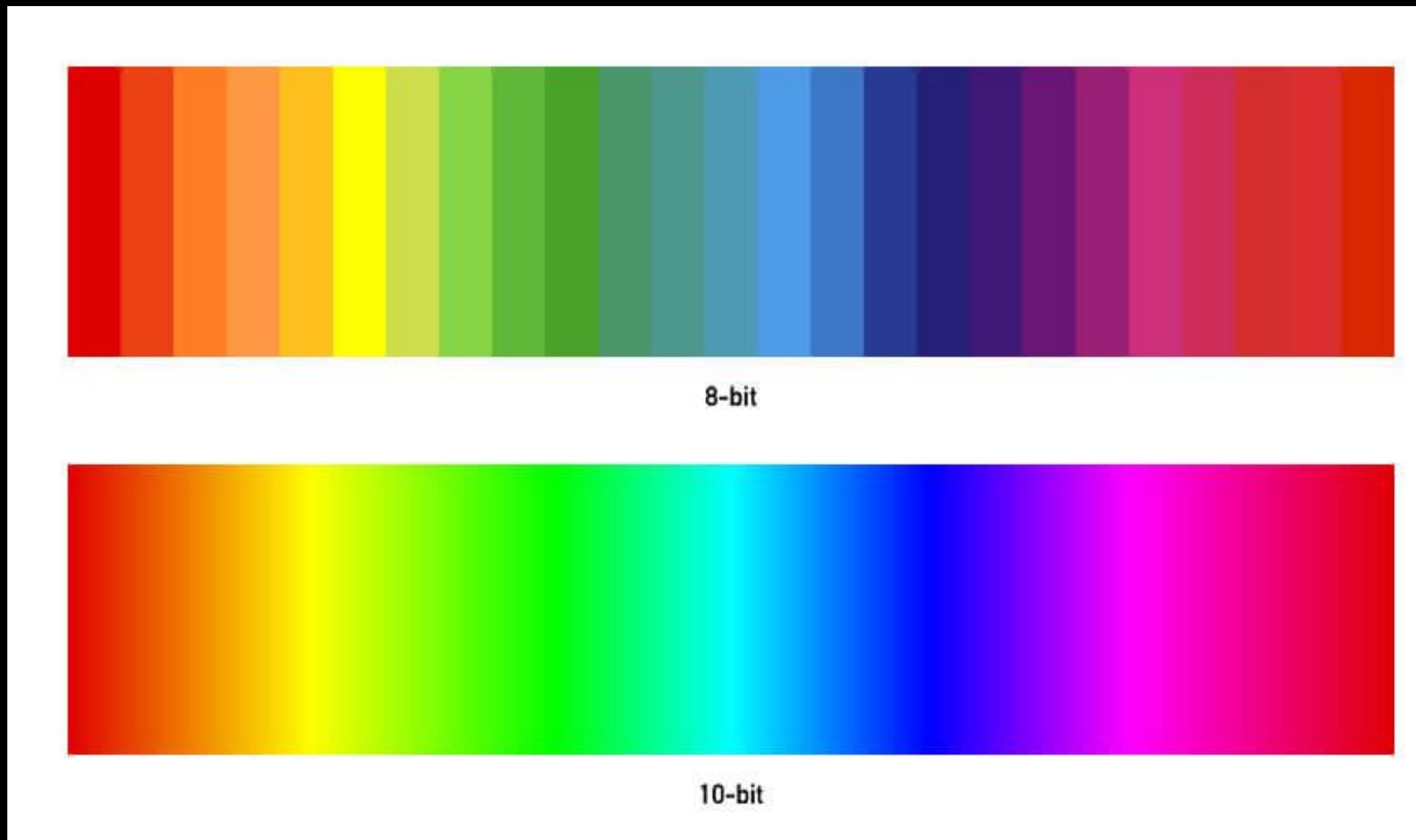
## Binary Representation (base 2)

| 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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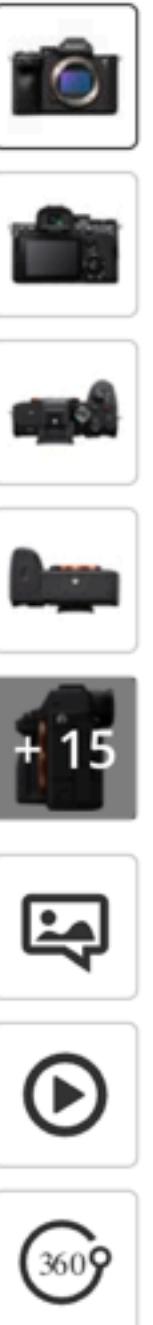
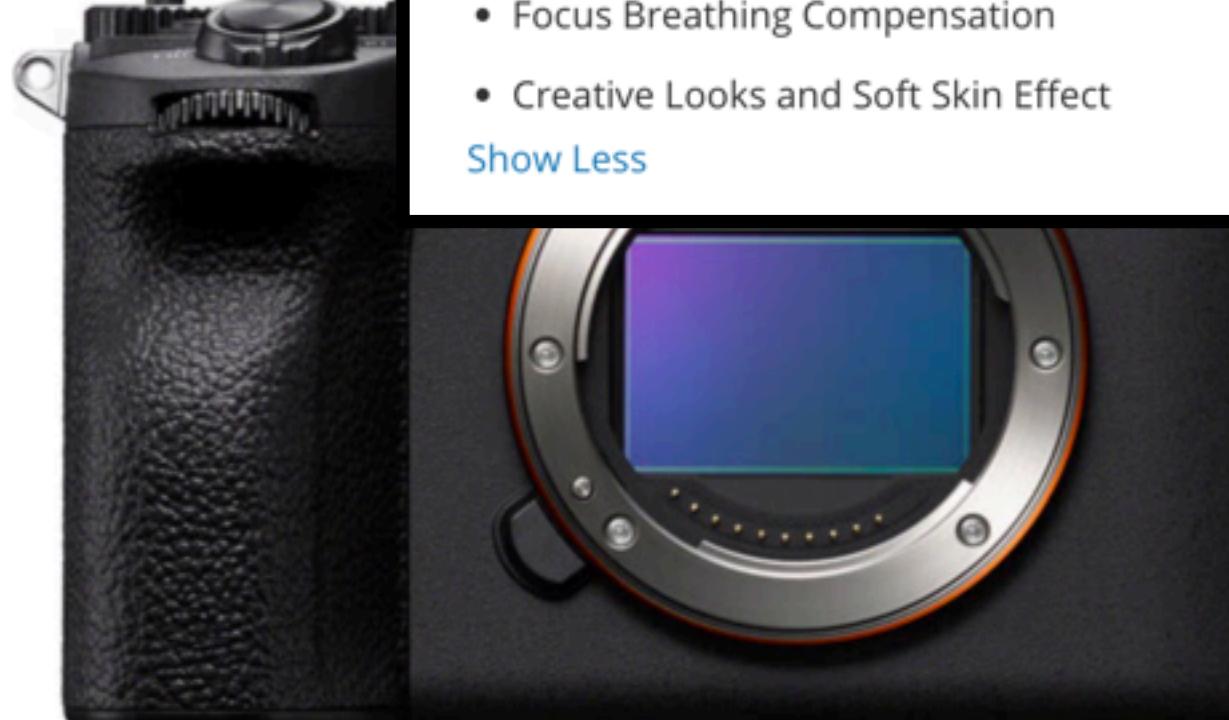
Home > Photography > Digital Cameras > Mirrorless Cameras > Sony Alpha A7 IV

## Sony a7 IV Mirrorless Camera

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

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### Key Features

- 33MP Full-Frame Exmor R CMOS Sensor
- 4K 60p Video in 10-Bit, S-Cinetone
- 3" 1.03m-Dot Vari-Angle Touchscreen LCD
- Focus Breathing Compensation
- Creative Looks and Soft Skin Effect
- Up to 10 fps Shooting, ISO 100-51200
- 3.68m-Dot EVF with 120 fps Refresh Rate
- 759-Pt. Fast Hybrid AF, Real-time Eye AF
- 5-Axis SteadyShot Image Stabilization
- 4K 15p UVC/UAC Streaming via USB Type-C

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days

12 Mos.

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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

Image from b&h

# Storing the Data

| Internal Video Capture | Chroma Subsampling  | Bit Depth |
|------------------------|---|-----------|
| Recording Modes        |   |           |
| Codec                  |   |           |
|                        | <b>H.265/XAVC HS 4:2:2 10-Bit</b><br>UHD 4K (3840 x 2160) at 23.98p/50p/59.94p [50 to 200 Mb/s]   |           |
|                        | <b>H.265/XAVC HS 4:2:0 10-Bit</b><br>UHD 4K (3840 x 2160) at 23.98p/50p/59.94p [30 to 150 Mb/s]   |           |
|                        | <b>H.264/XAVC S-I 4:2:2 10-Bit</b><br>UHD 4K (3840 x 2160) at 23.98p/25p/29.97p/50p/59.94p [240 to 600 Mb/s]<br>Full HD (1920 x 1080) at 23.98p/25p/29.97p/50p/59.94p [89 to 222 Mb/s]    |           |
|                        | <b>XAVC S 4:2:2 10-Bit</b><br>UHD 4K (3840 x 2160) at 23.98p/25p/29.97p/50p/59.94p [100 to 200 Mb/s]<br>Full HD (1920 x 1080) at 23.98p/25p/29.97p/50p/59.94p [50 Mb/s]                   |           |
|                        | <b>XAVC S 4:2:0 8-Bit</b><br>UHD 4K (3840 x 2160) at 23.98p/25p/29.97p/50p/59.94p [60 to 150 Mb/s]<br>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

CAPTURE

DELIVER

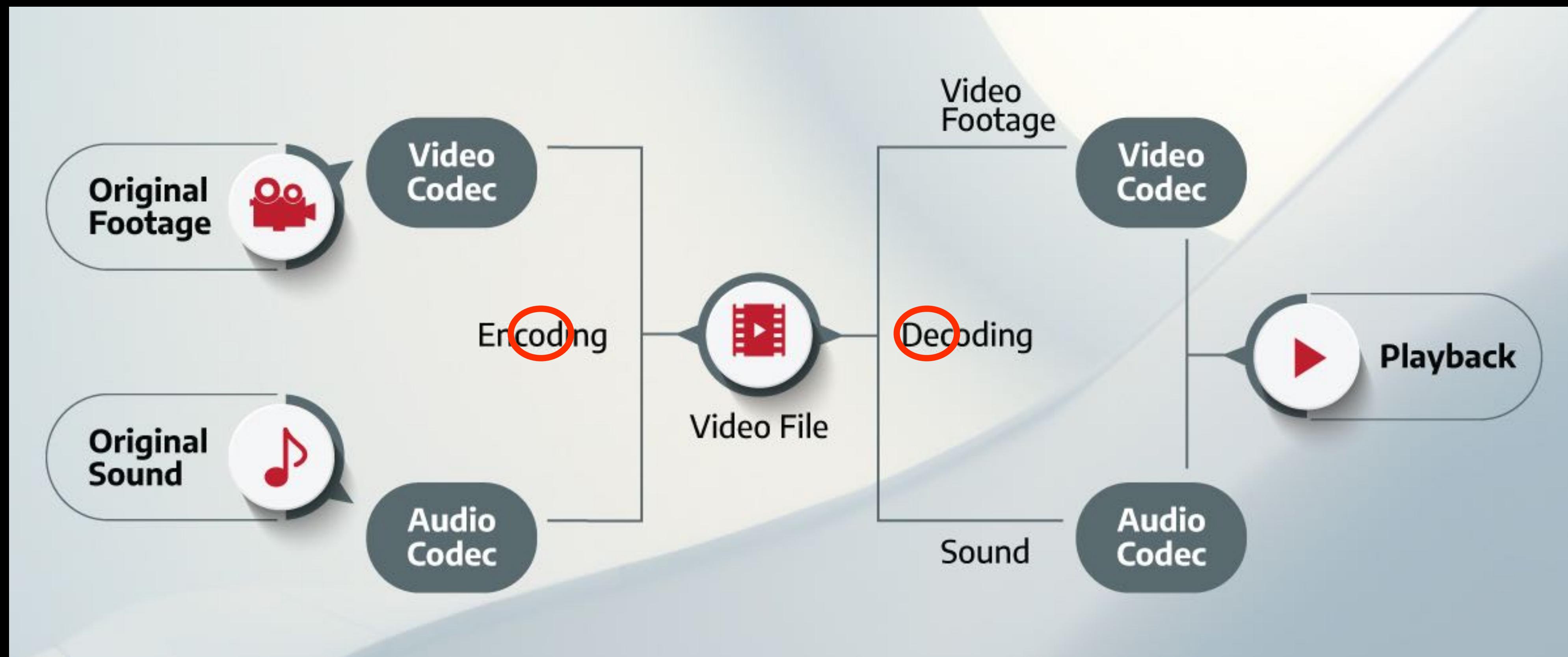
Processing Pipeline

At least 10-bit 422 when possible

depends\*

# Video Compression

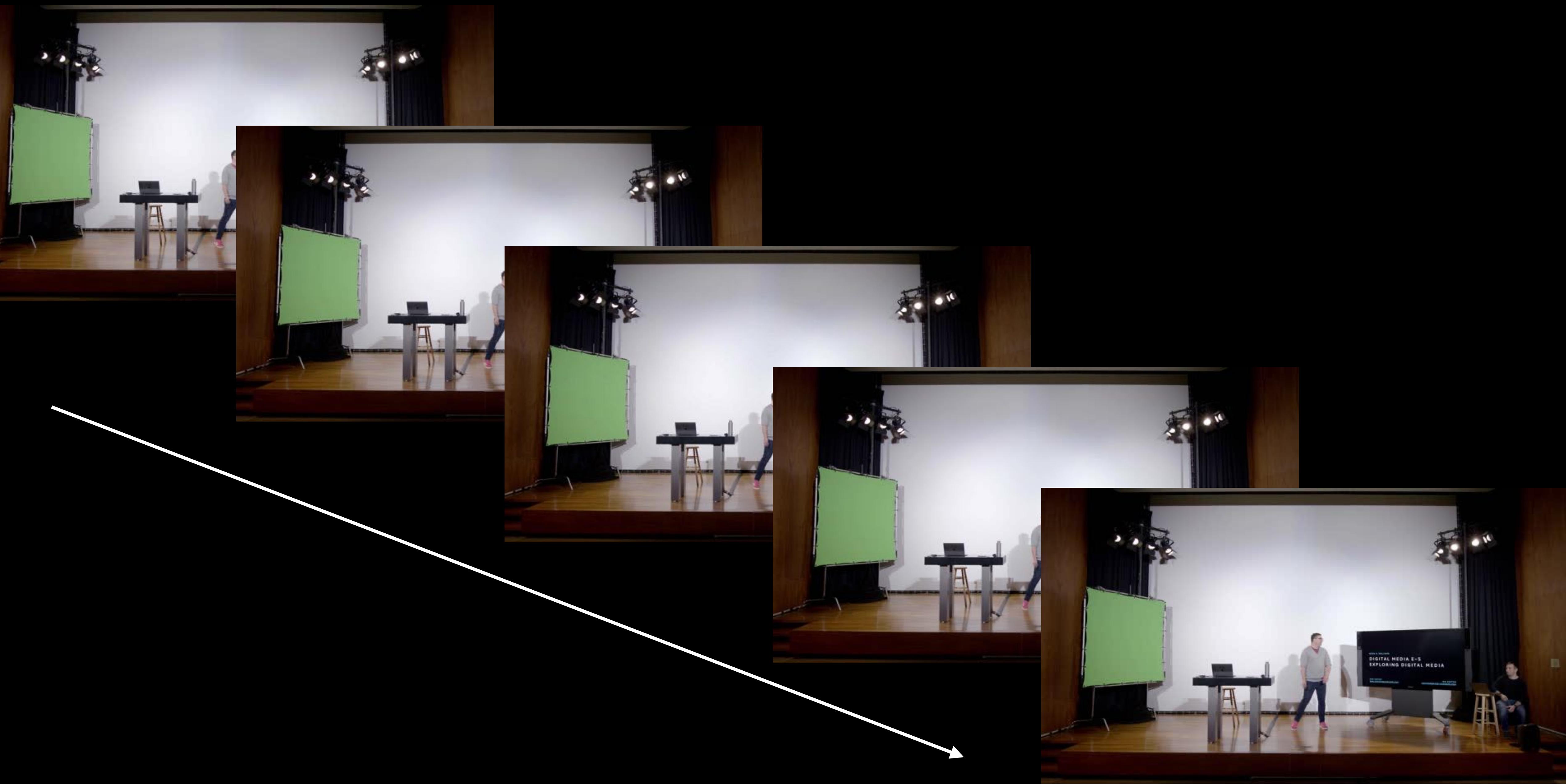
Codec



Encoder Decoder

# Video Compression

## Frames



# Video Compression

# Frames



# Video Compression

## Frame Types

GOP "Group of Pictures"  
Temporal Compression

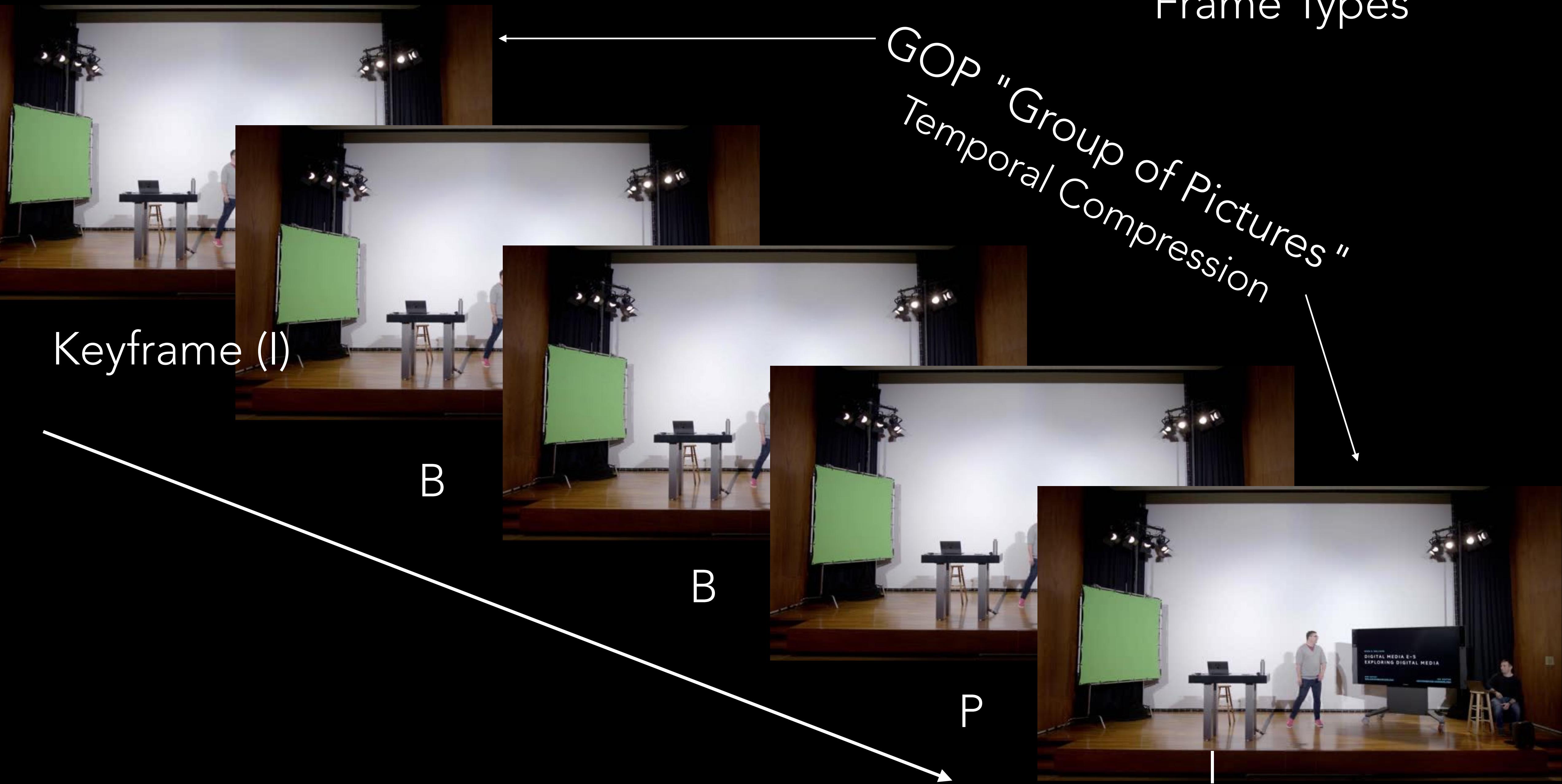
Keyframe (I)

B

B

P

I



# Video Compression

# Frames



# Video Compression

my\_file.mp4

Metadata

Video Track (h264 codec)

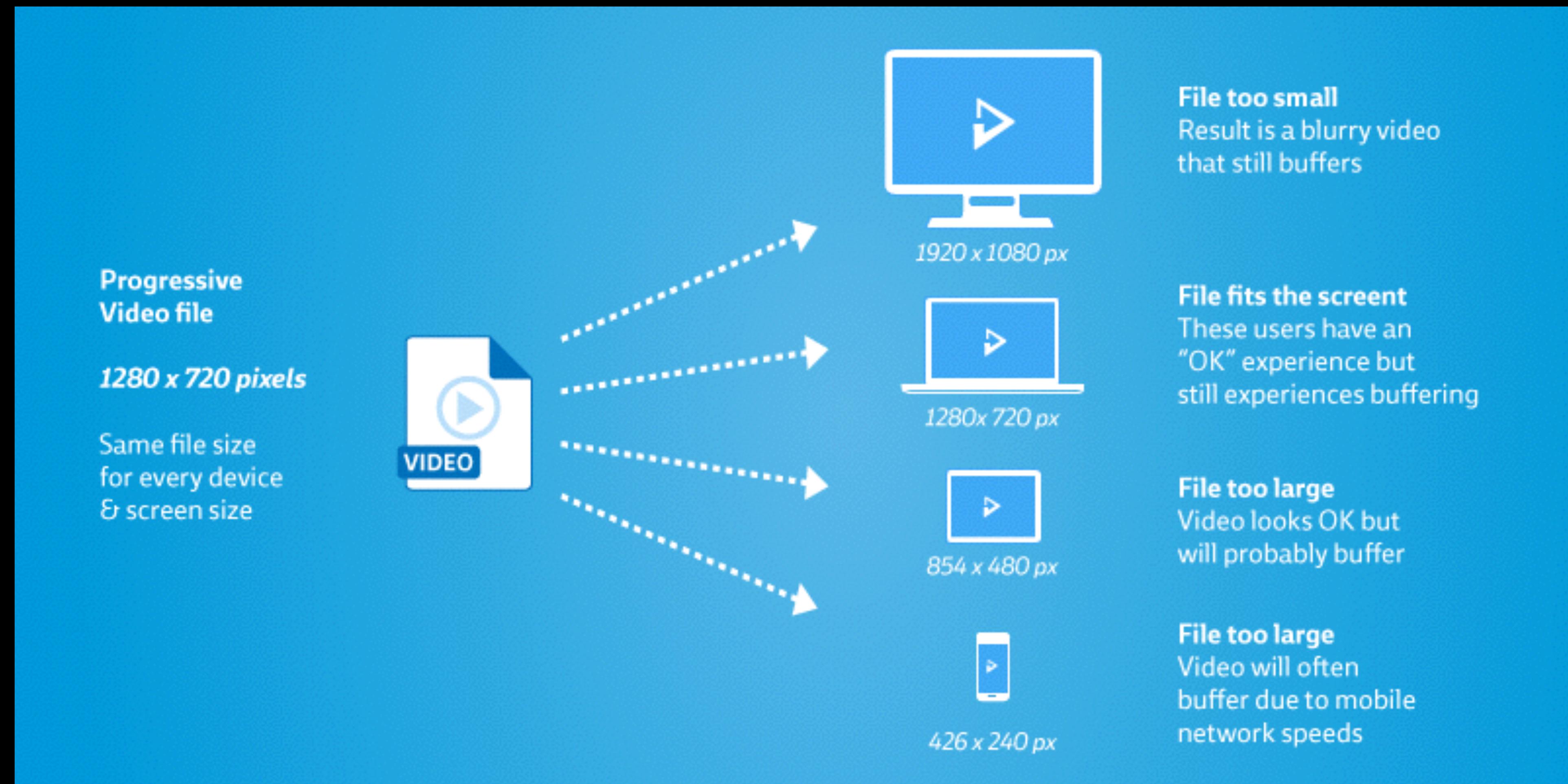
Audio Track (aac codec)

# Video Delivery

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

# Video Delivery

## Single File Approach (progressive download)



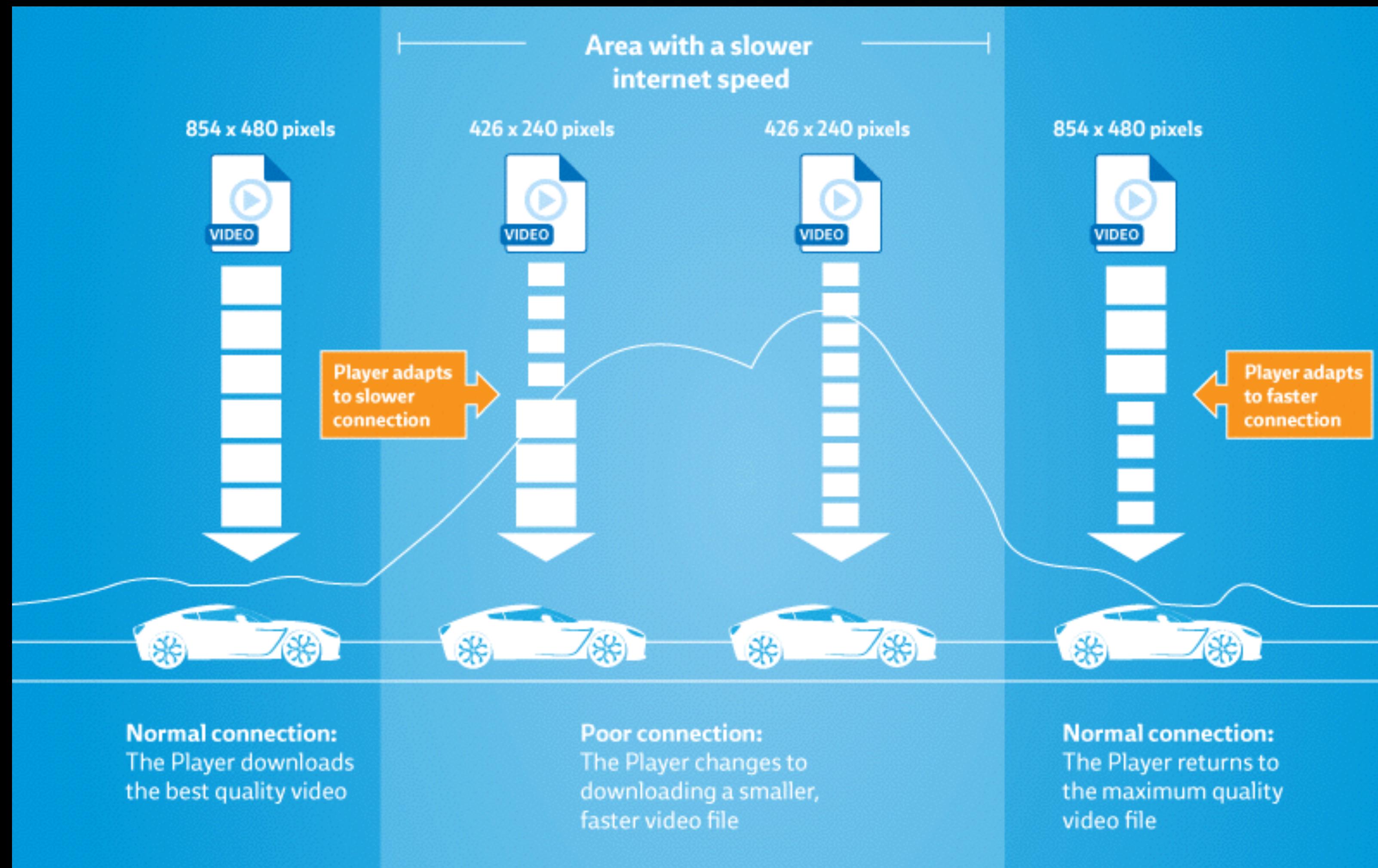
# Video Delivery

## Adaptive Bitrate



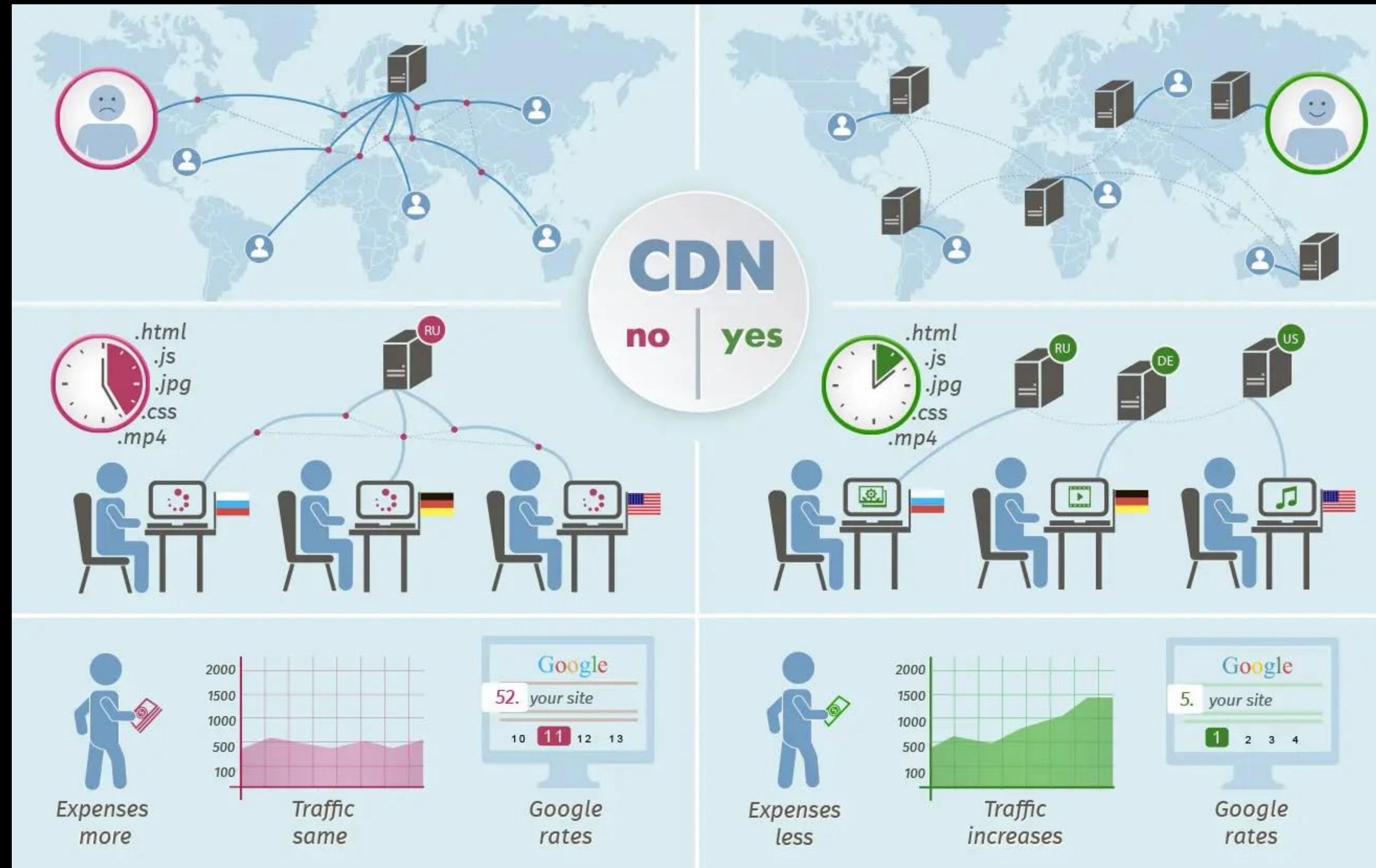
# Video Delivery

## 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)<br>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?



*"artist's representations"*

Image from [amazon](#)

# High Dynamic Range (HDR) Video

## What is HDR, Why?

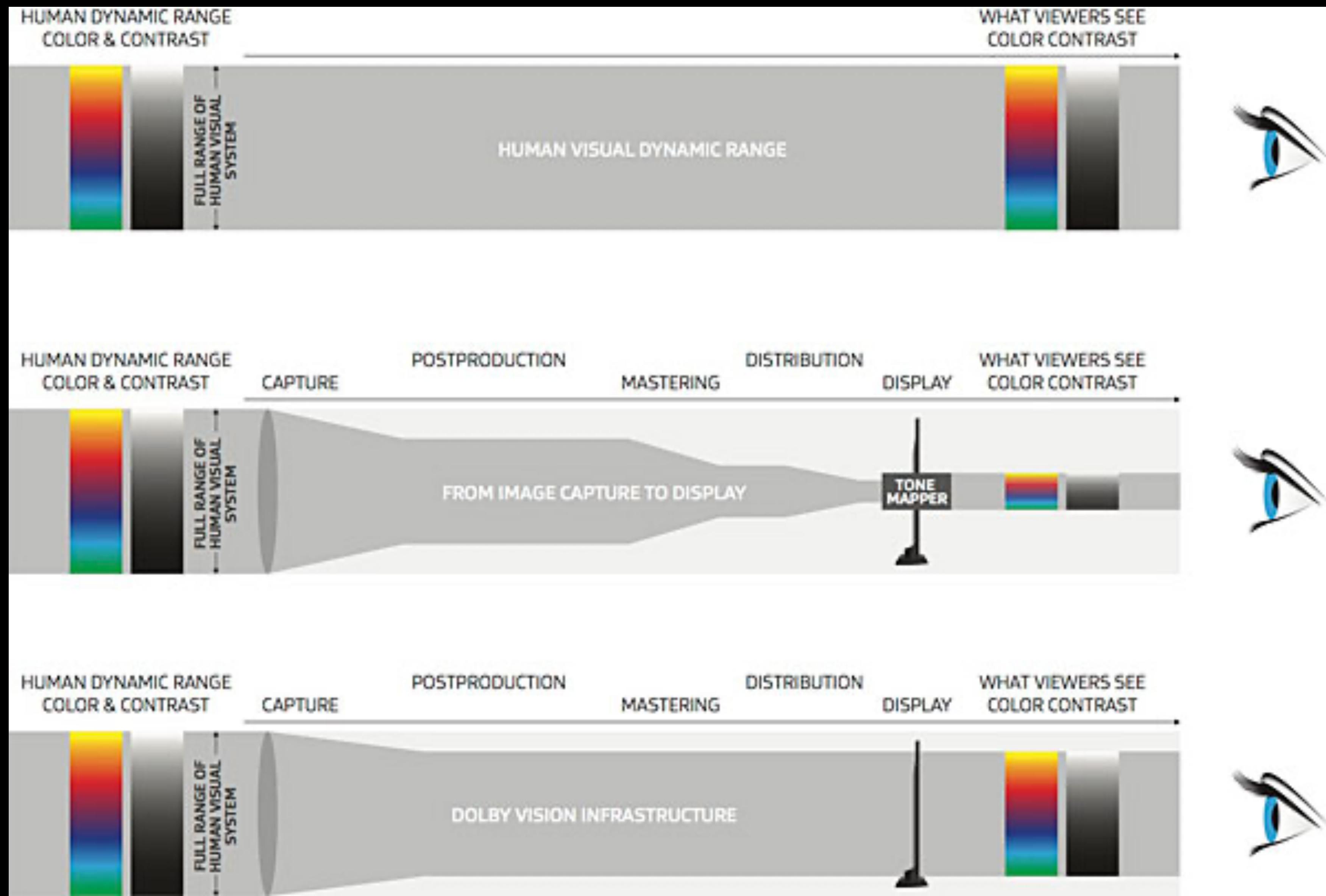
SDR image



HDR image

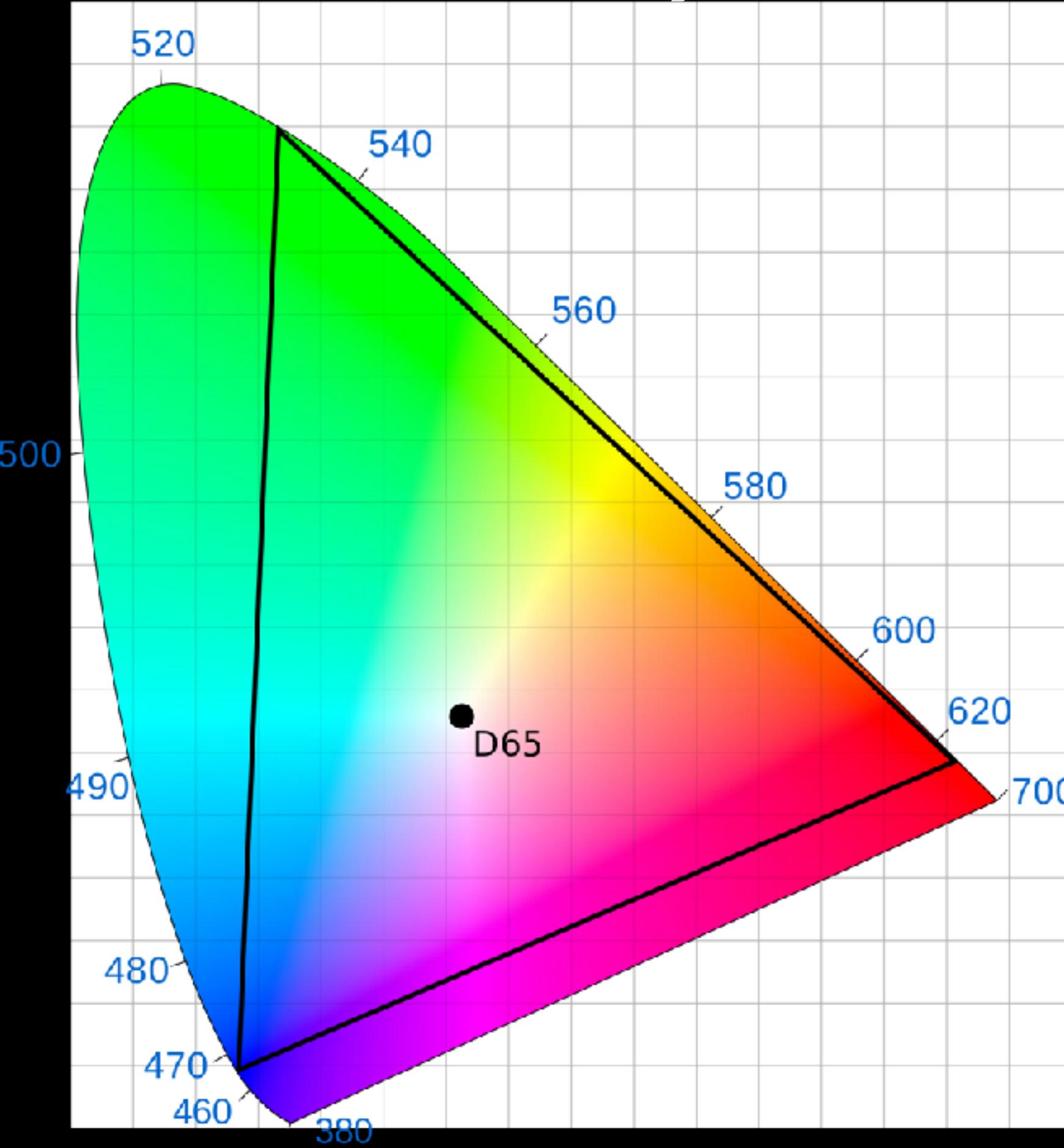


# High Dynamic Range (HDR) Video

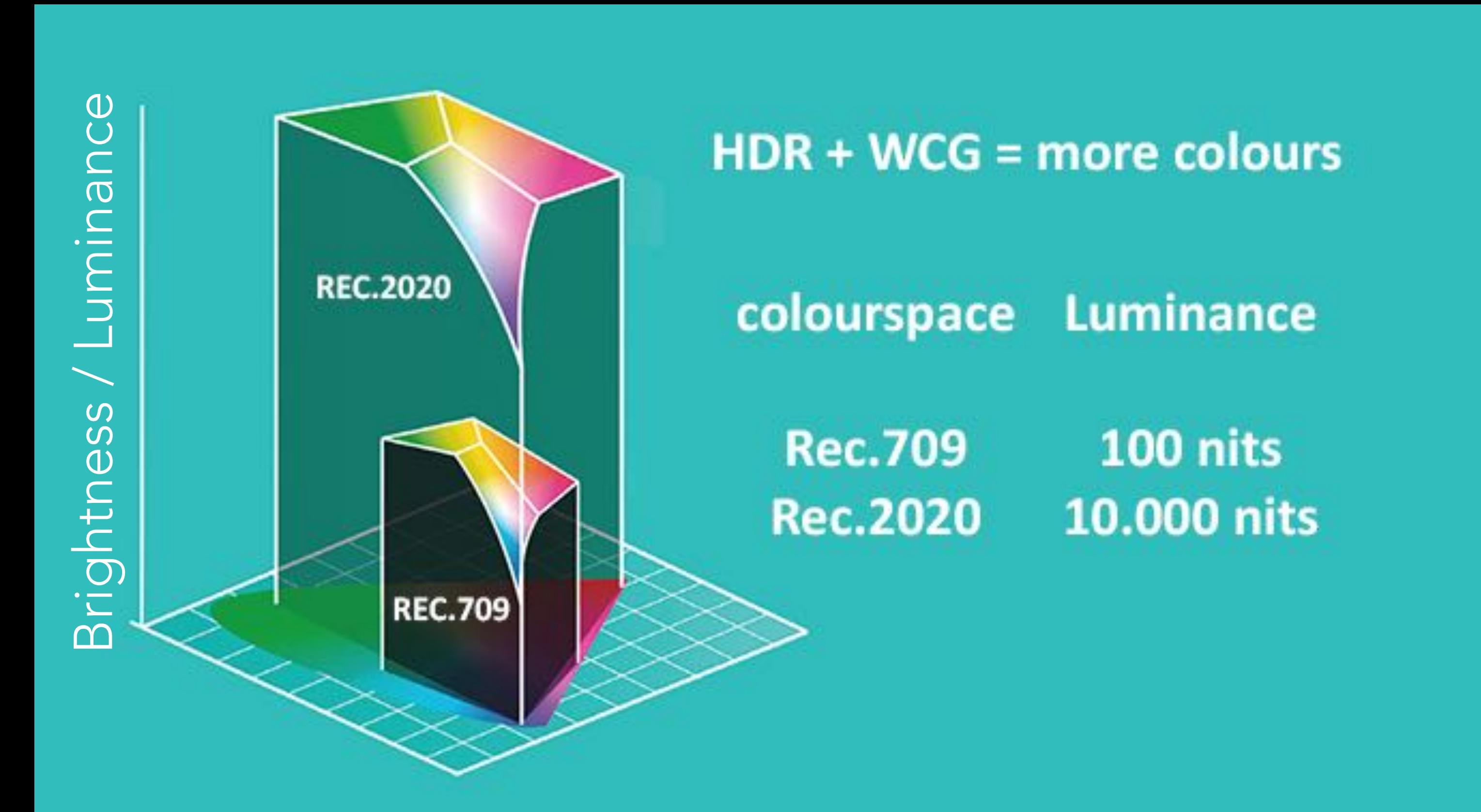


# High Dynamic Range (HDR) Video

## What is HDR, Why?



Wide Color Gamut (WCG)



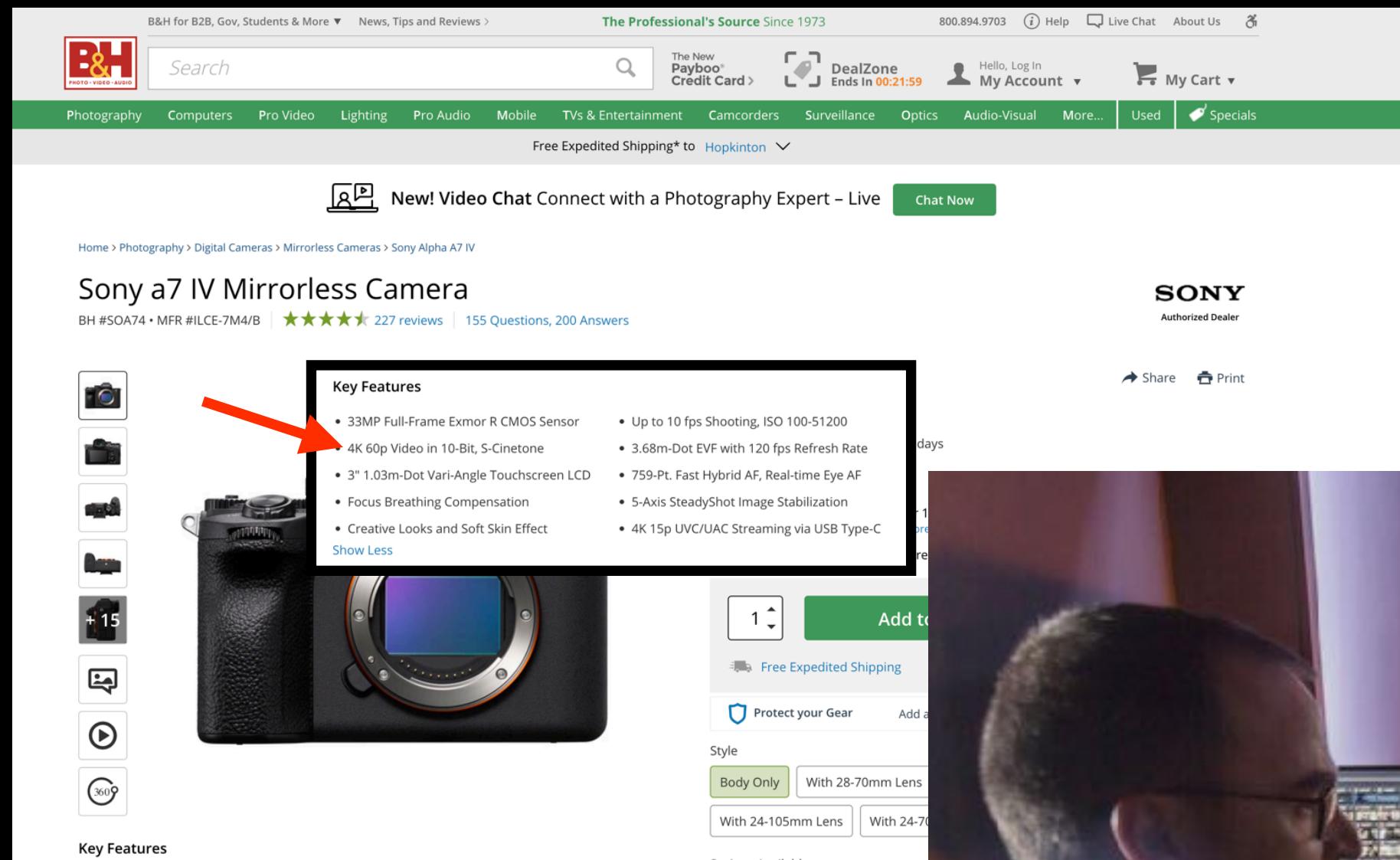
# High Dynamic Range (HDR) Video



# 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



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## Sony a7 IV Mirrorless Camera

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- 759-Pt. Fast Hybrid AF, Real-time Eye AF
- 5-Axis SteadyShot Image Stabilization
- 4K 15p UVC/UAC Streaming via USB Type-C

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Style

Body Only With 28-70mm Lens

With 24-105mm Lens With 24-70mm Lens

Sauvages Available:

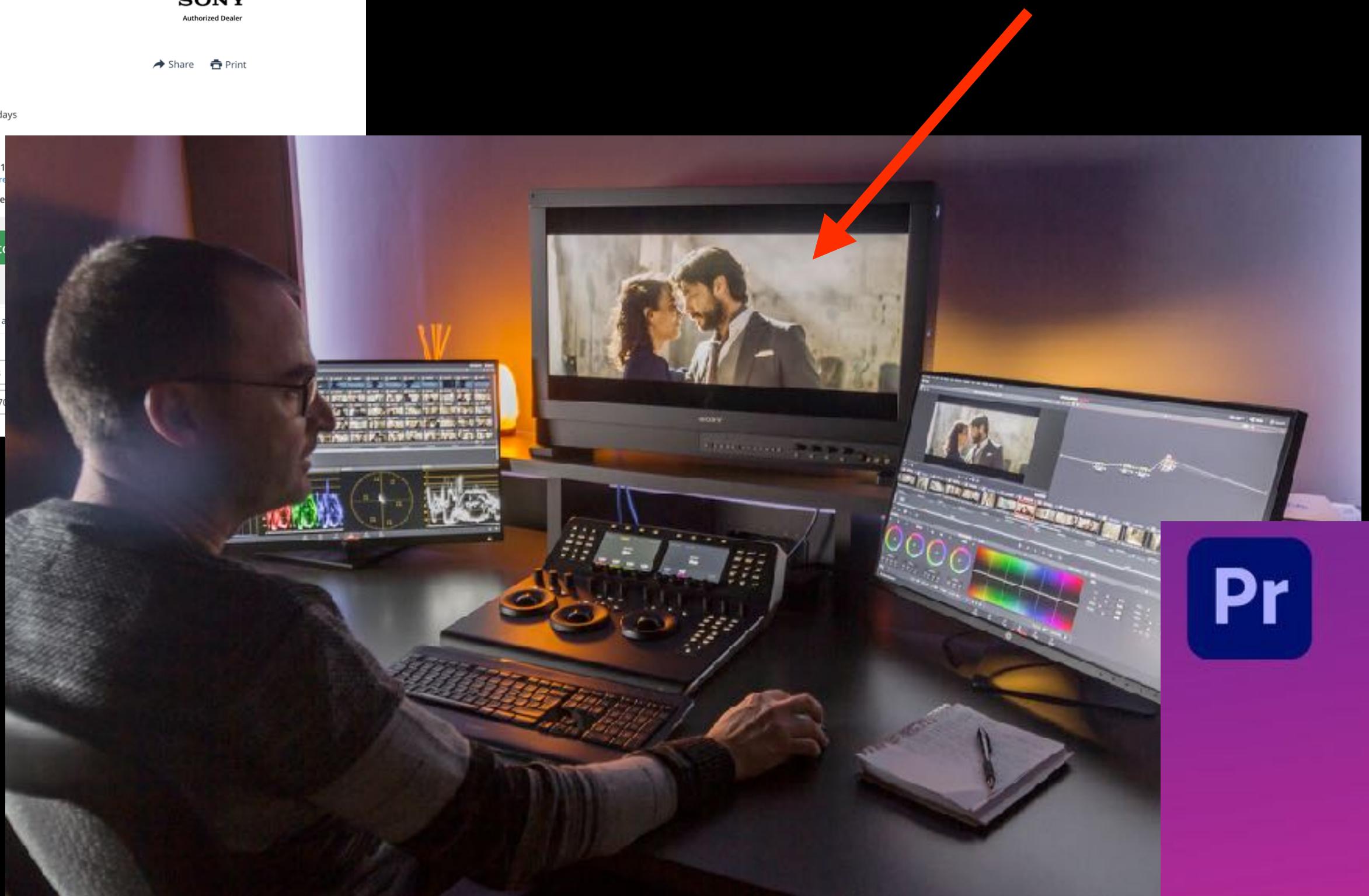


Image from [b&h](https://www.bhphotovideo.com)

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

Image from [https://www.youtube.com/](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**



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.

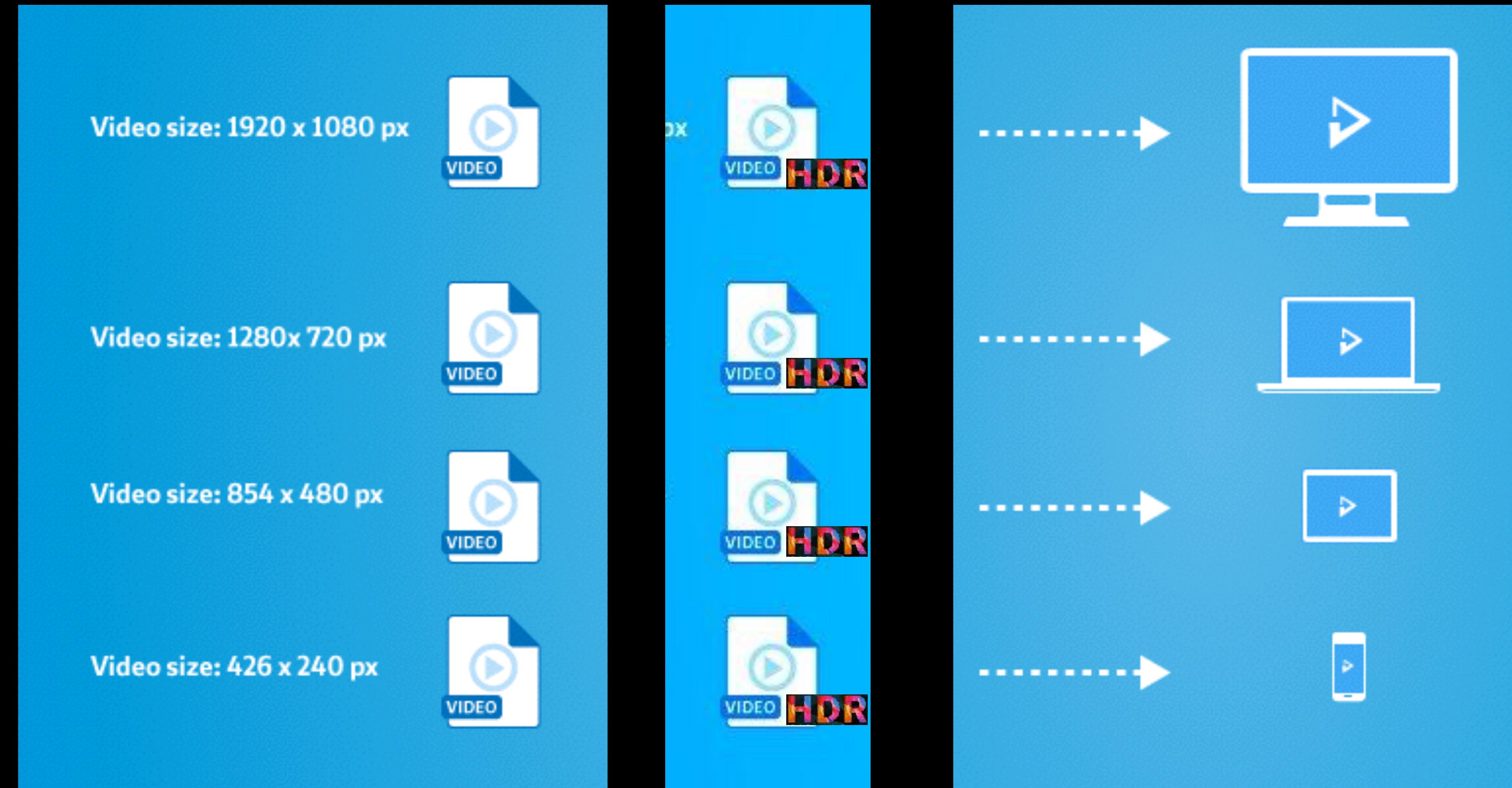
**Lock Camera**



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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