

HIGH DYNAMIC RANGE (HDR) VIDEO

Digital Preservation

Cine-GT 1807

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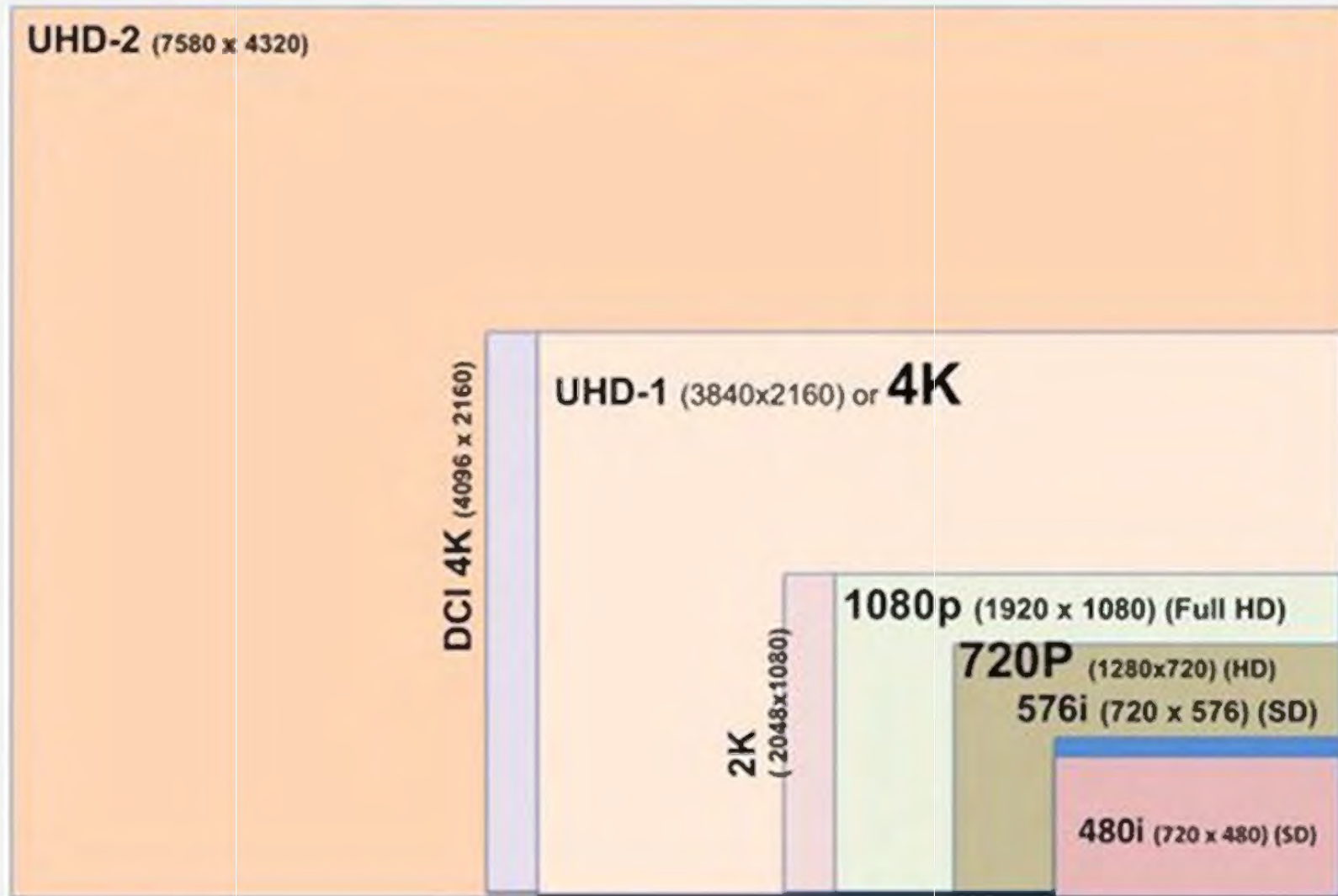
Instructor: Nicole Martin

OUTLINE

- Introduction
- Production
- Distribution
- Preservation

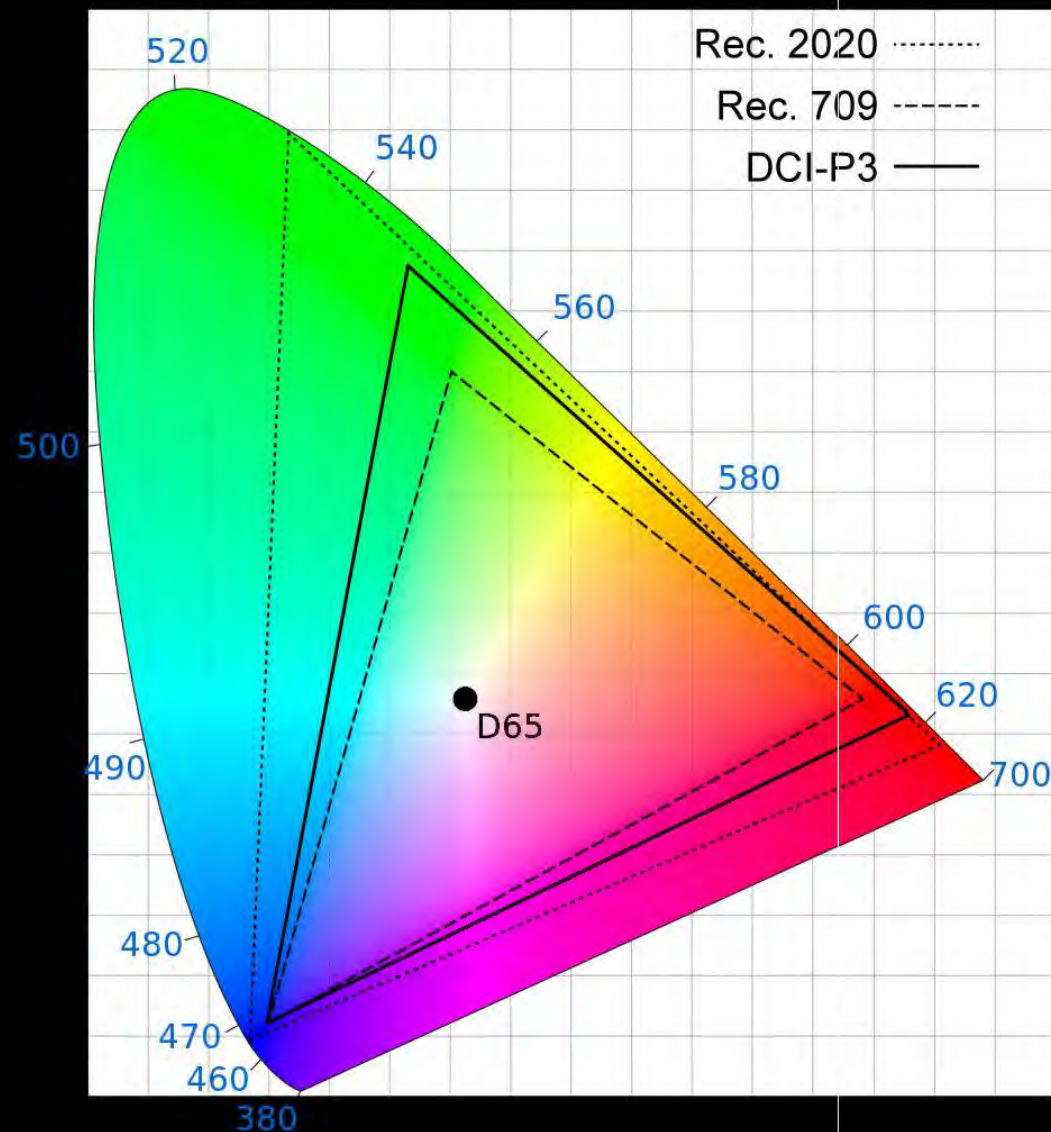
RESOLUTION

- 8K
 - 7869 x 4320 pixels
 - Vimeo uploads already available
- 4K
 - 3840 x 2160 pixels
 - 4K Cinema
 - 4096 x 2160 pixels
- 2K
- Full-HD



COLOR

- Color Depth
 - 8-bit
 - 10-bit
 - 12-bit
- Color Gamut
 - BT.709
 - 36% of the visible color spectrum
 - DCI-P3
 - Intermediate standard
 - 62%
 - BT.2020
 - Exceeds the gamut of actual monitors
 - 76%



DYNAMIC RANGE

- Ratio of maximum to minimum light intensity
- Measured in f-stops
- Film captures 15.5 f-stops
- Experimental film captured 26 f-stops
- Rocket launch is 20 f-stops
- HDR over 16 f-stops
- SDR less than 10 f-stops

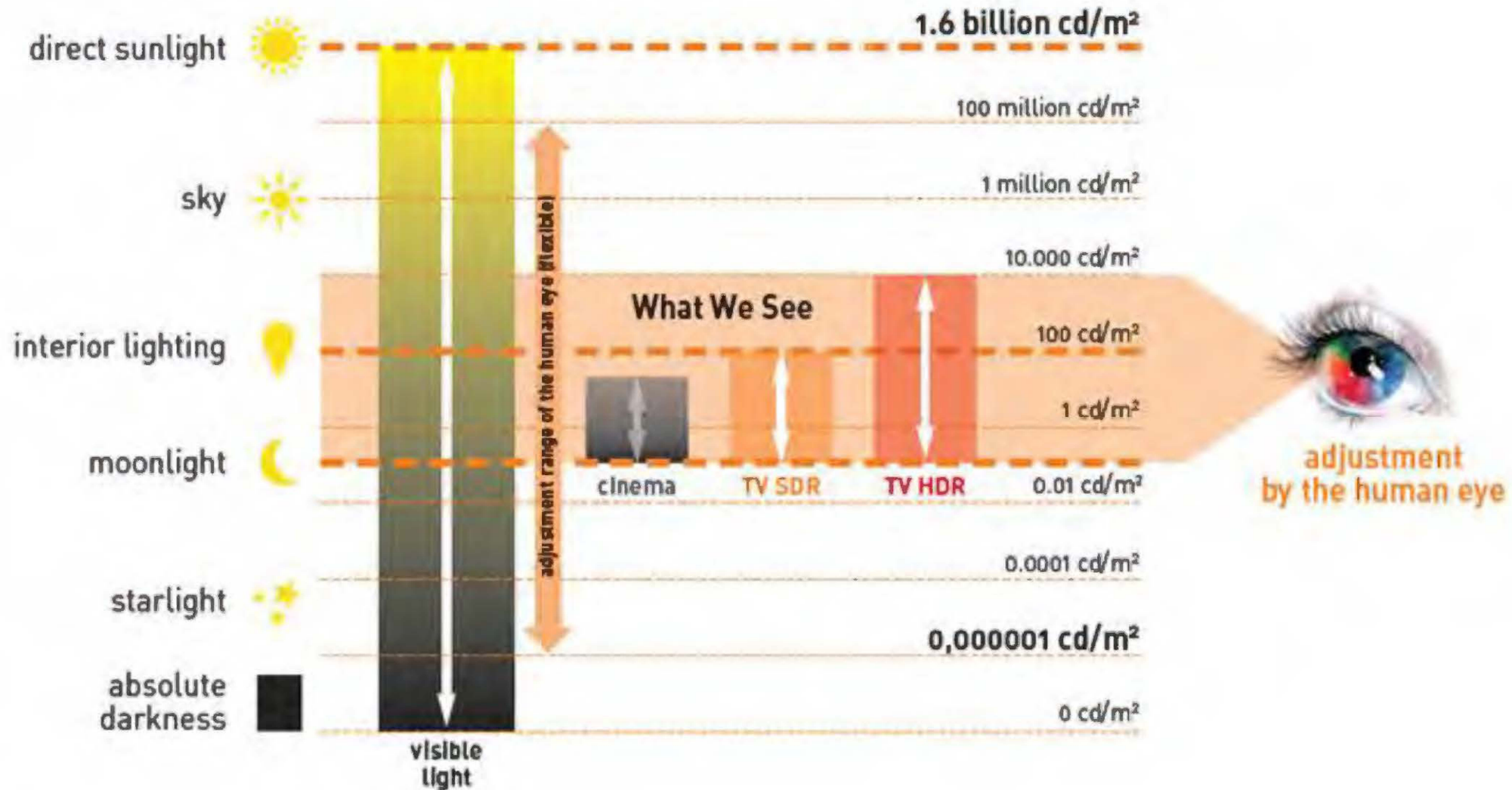


HDR VIDEO

- Different from HDR still images
- First displays in 2004
- First cameras in 2009
- Greater contrast ratio
- Brighter highlights
- Improved detail in dark areas
- Measured in nits (candela per square meter, cd/m^2)

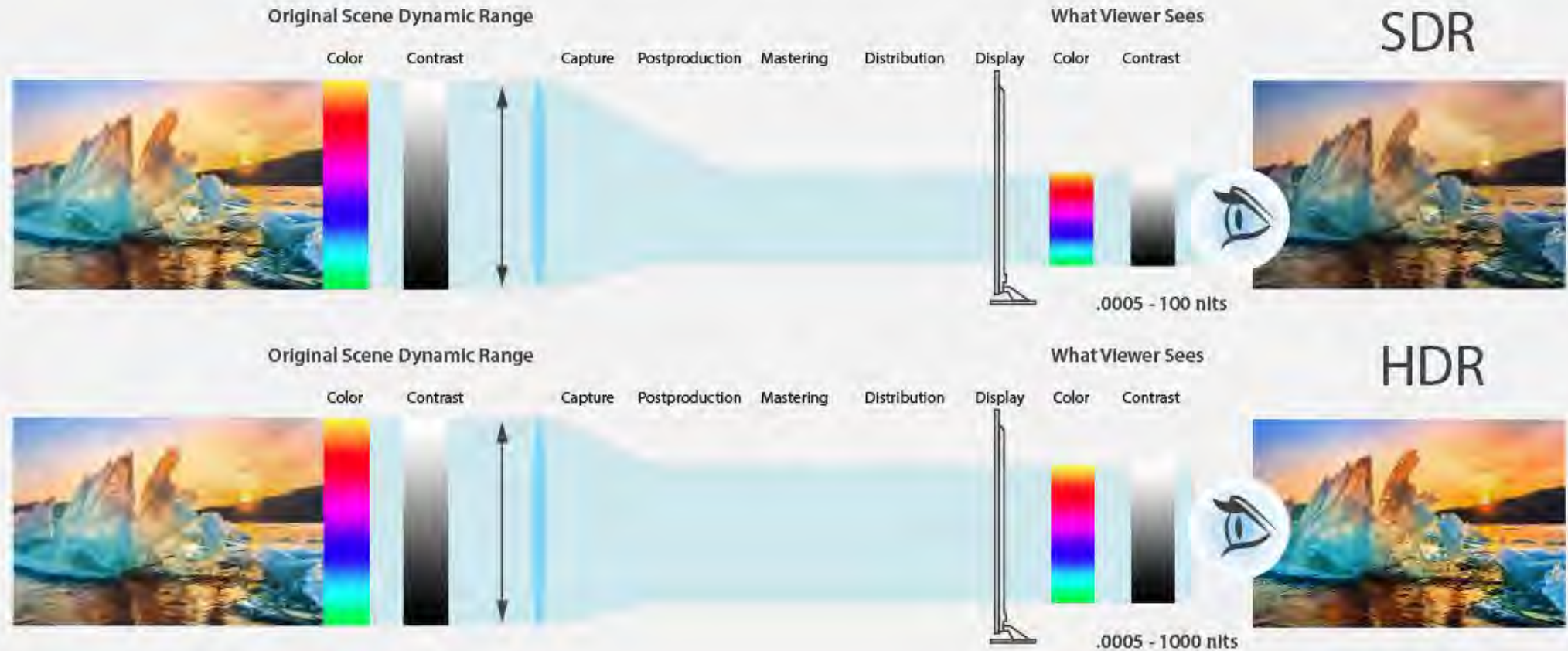


Real World



PRODUCTION

- Commercial camera systems capture 18 f-stops or less
- Cameras have been capturing HDR since 2010



TRANSFER FUNCTION AND HDR METADATA

- HDR display format is determined by its Transfer Function (EOTF)
 - “The description of how to convert the signal’s carrier (analog voltage, film density, or digital code values) to optical energy” -SMPTE
- End-to-end control over image using unique HDR metadata
 - Embedded during color-grading and mastering
 - Static Metadata
 - Dynamic Metadata

Color primaries: BT.2020

Transfer characteristics: PQ

Matrix coefficients: BT.2020 non-constant

Mastering display color primaries: R: $x=0.680000$ $y=0.320000$, G: $x=0.265000$ $y=0.690000$, B: $x=0.150000$ $y=0.060000$, White point: $x=0.312700$ $y=0.329000$

Mastering display luminance: min: 0.0500 cd/m^2 , max: 1200.0000 cd/m^2

HDR TRANSFER FUNCTIONS

- Hybrid Log Gamma (HLG)
 - Designed by BBC and NHK
 - Maintains backwards compatibility with SDR
 - No display metadata needed
- Perceptual Quantizer (PQ)
 - Open
 - HDR10 Static Metadata
 - HDR10+ Dynamic Metadata
 - Proprietary
 - Dolby Vision Dynamic Metadata



VS



CODECS

- Uncompressed
 - Single frame at 4K = 95 MB
 - One minute at 30 fps = 167 GB

- HEVC / H.265
 - MPEG standard
 - Supersedes AVC / H.264

- VP9
 - Youtube open source
 - Competes with HEVC

Container

MOV/QuickTime

Encoding

H.264 10 bit

VP9 Profile 2

ProRes 422

ProRes 4444

DNxHR HQX

MP4

H.264 10 bit

VP9 Profile 2

DNxHR HQX

MKV

H.264 10 bit

VP9 Profile 2

ProRes 422

ProRes 4444

DNxHR HQX

MEDIAINFO TESTS

Video Transfer Characteristics

- PQ
- HLG

Video Color Primaries

- BT.2020

Video Format

- HEVC



CONTENT

- **Streaming**
- **Discs**
- **Movie Theatres**
- **Broadcasting**



STREAMING

Services

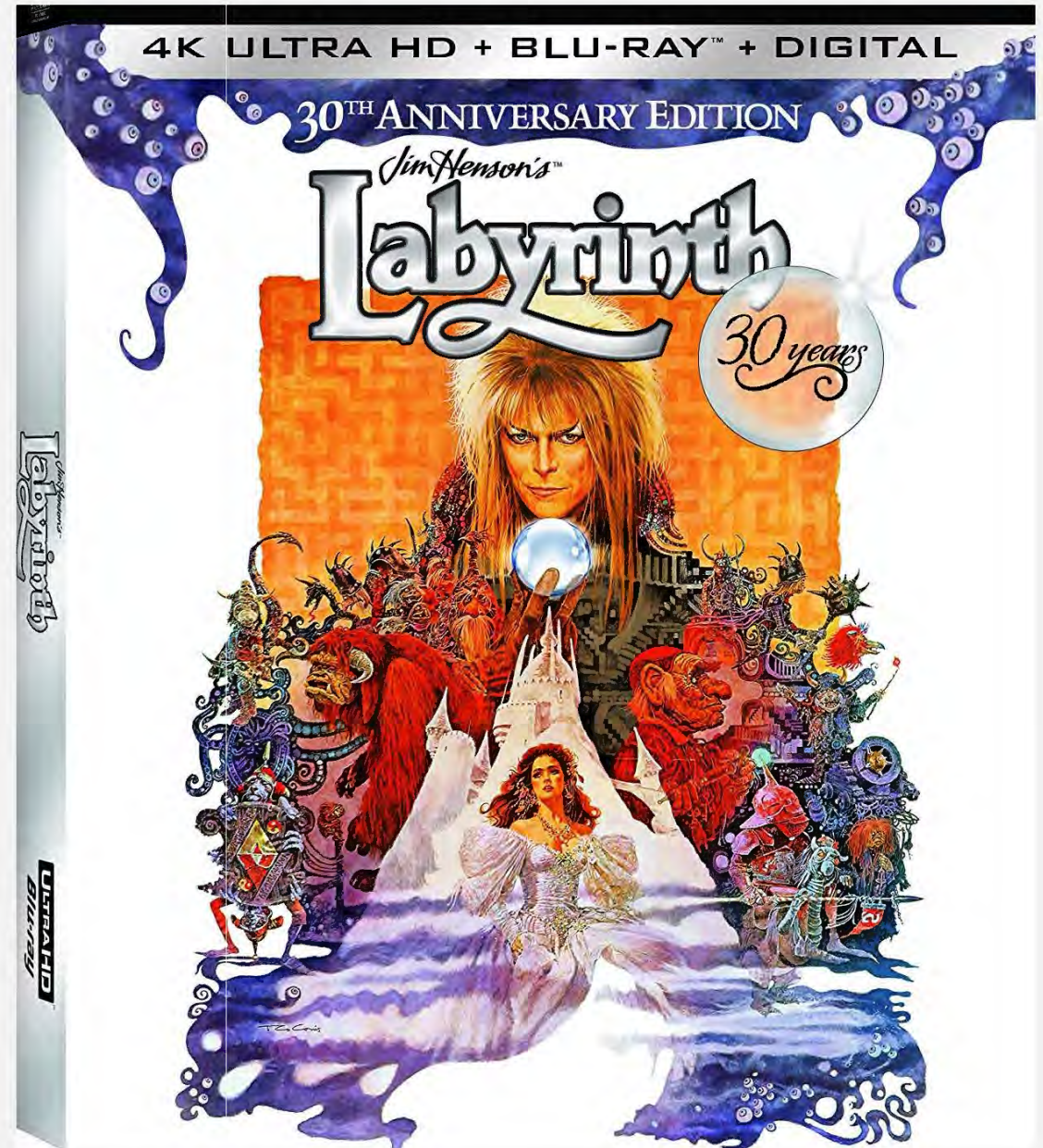
- Netflix
- Amazon
- Vudu
- iTunes
- Vimeo
- Youtube

Devices

- Roku
- Apple TV
- Amazon Fire
- Google ChromeCast
- Smart TVs
- UltraHD Disc Players

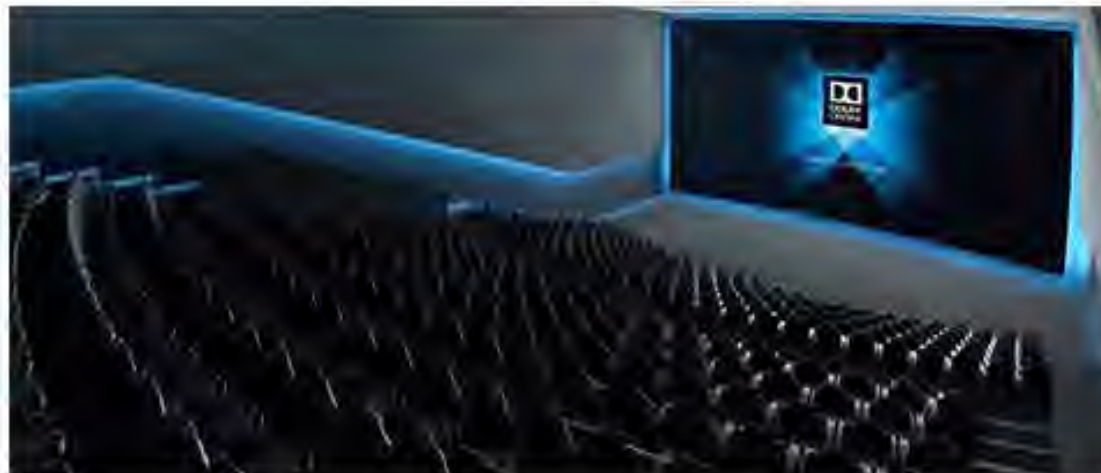
UHD DISCS

- Firsts discs in March 2016
- Dolby Vision discs in June 2017
- HEVC
- 4K
- HDR
- High frame rate



CINEMA

- Dolby Cinema
- 2 laser projectors
- 77 Locations in the USA
- AMC Empire 25 in Manhattan



BROADCASTING

- Issues
 - Backwards compatibility
 - Reliance on metadata
- HLG
 - Japan and Europe
 - Backwards compatible with SDR displays
- ATSC 3.0 standard in USA
 - Over-the-air 4K, HDR, BT.2020
 - Approved by FCC in November 2017

HDR IN ARCHIVES

- CUNY TV
 - No HDR production
 - Would not make a difference in the archive's workflow
- Human Rights Watch
 - Some 4K content
 - Distribution in in 1080i