

The Future of Television?

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4k,8k, HDR??

- **TV Manufacturers need to drive new demand**
- **This could also offer consumers a better viewing experience**

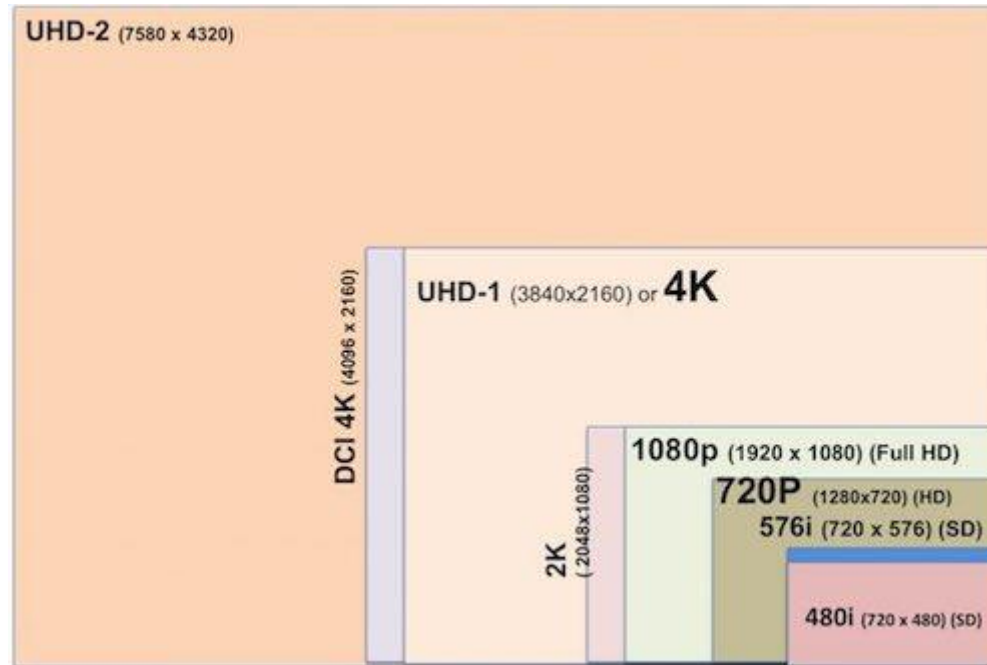
But...

- **Will consumers be willing to pay more?**
- **Will content be available?**
- **Will distribution platforms support the new standards?**
 - **Sky**
 - **Virgin Media**
 - **Terrestrial (BBC, ITV etc)**
 - **Netflix**
 - **Amazon Prime**

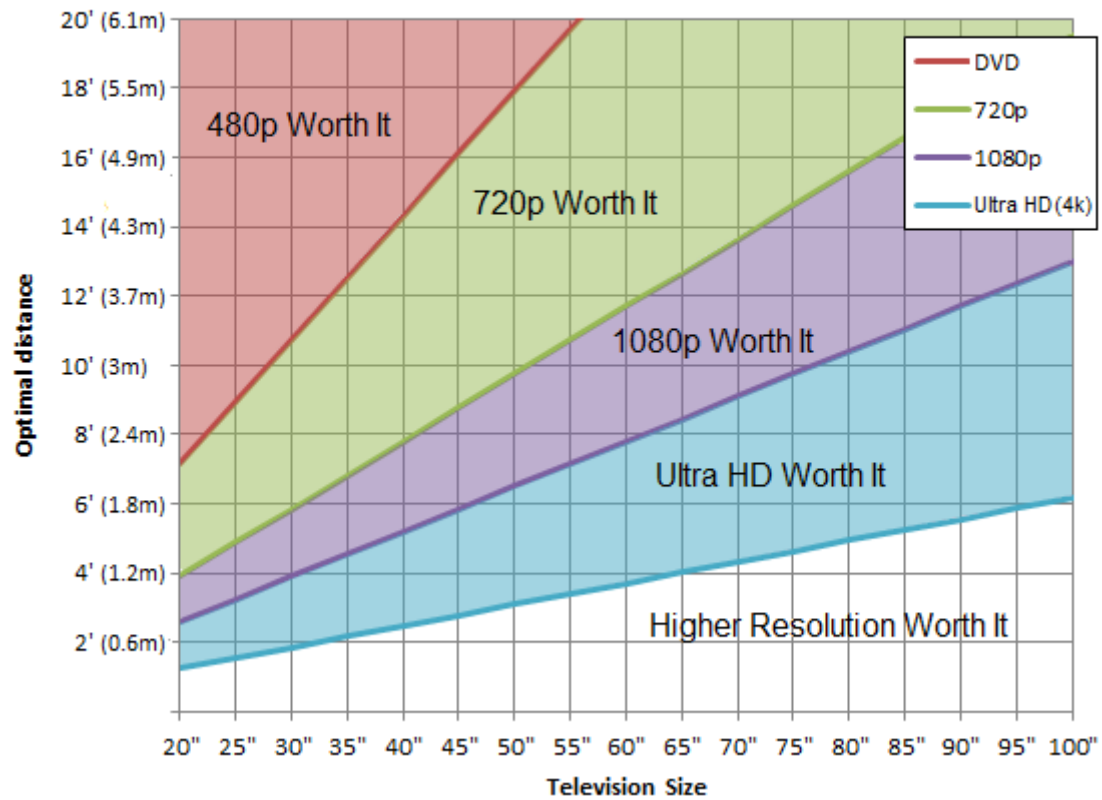
Terminology and Issues

- **Display Resolutions – SD, HD, UHD-1, UHD-2**
- **Ideal Viewing Distances**
- **Display Technologies – LCD, OLED, QLED**
- **Frame Rates – Interlaced v Progressive Scan**
- **Display Colour Palette - REC709 vs REC2020**
- **High Dynamic Range - HDR10, Dolby Vision**
- **Chroma sub-sampling – YCrCb 4:4:4, 4:2:2, 4:2:0**
- **Video Compression, H.264, H.265**
- **HDMI Bandwidth and Standards Roadmap**
- **UHD Alliance**

Display Resolutions



Optimal viewing distance by the size of the television and the resolution



Display Technologies

LCD

- Liquid Crystal Display
- Separate backlight needed that's passed through a layer of pixels
- Low cost, widely available technology but light bleed is an issue

OLED

- Organic Light Emitting Diodes
- Carbon based film placed between two conductors
- Pass current through to cause film to emit light on a pixel-by-pixel basis
- Bright pixels next to dark pixels with no light bleed
- Excellent blacks but lower peak brightness
- Lighter and thinner than typical LCD/LED arrangement
- Expensive to produce
- LG only provider of TV panels currently but do sell to other TV manufacturers

QLED

- Quantum-dot Light Emitting Diodes
- Samsung promoting QLED
- In theory can produce bright vibrant colours
- Current generation still requires backlighting
- Pixel bleeding issues, poorer blacks

Next Gen QLED

- Eliminates the need for backlighting
- Not commercially available yet

Frame Rates

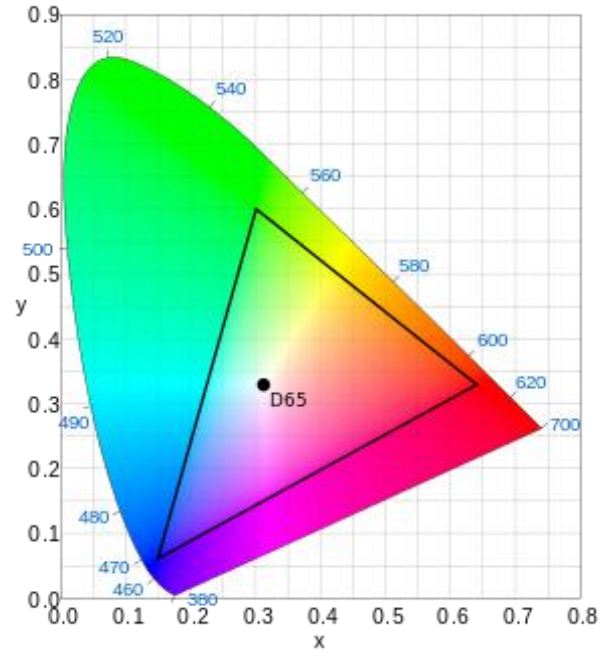
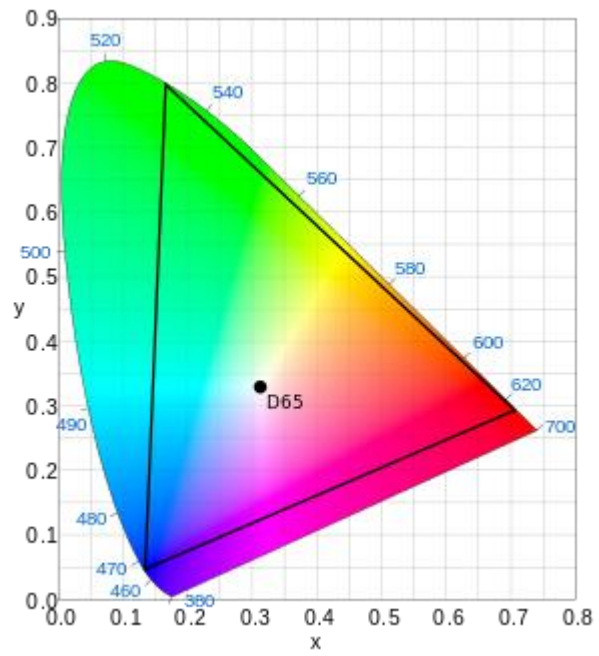
25, 50, 30, 60, 100 or 120 frames per second

Progressive or Interlaced (p or i)



e.g. 1080i50 or 1080p50

Display Colour Palette REC709 vs REC2020

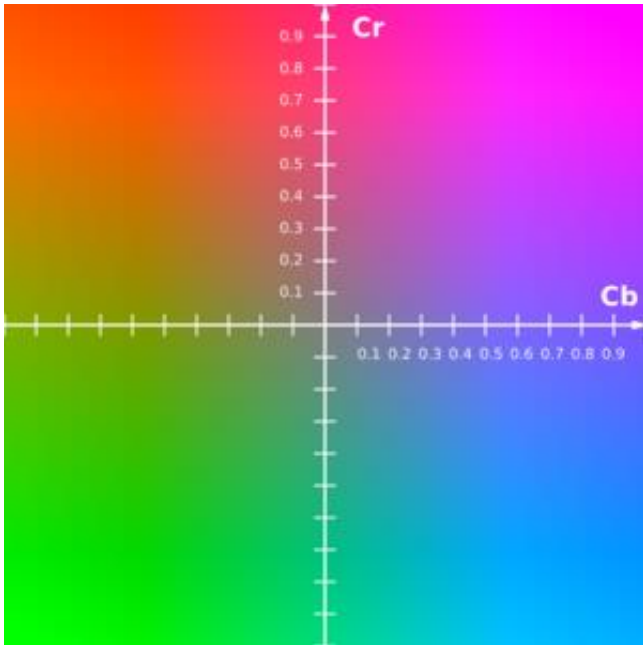


High Dynamic Range

- Difference between brightest whites and darkest blacks
- Measured in Candelas per square metre cd/m^2 known as “nits”
- Standard TVs 300-500 nits. HDR TVs up to 1000 nits
- Initially no agreed standards
- Now 2 main standards prevail HDR10 an open standard (10-bit) and the proprietary standard Dolby Vision (12-bit)
- UHD Alliance Ultra HD Premium certification mandates these standards

Chroma Sub-Sampling

- Digital signals are often compressed to save transmission bandwidth
- Displays are made up of Red, Green and Blue elements
- These are not efficient for storage or transmission
- Using YCbCr colour space enables greater compression
- Human visual system is more sensitive to variations in brightness than colour
- Video can be compressed by devoting more bandwidth to Luma component (Y)
- Less bandwidth to colour difference components Cr and Cb

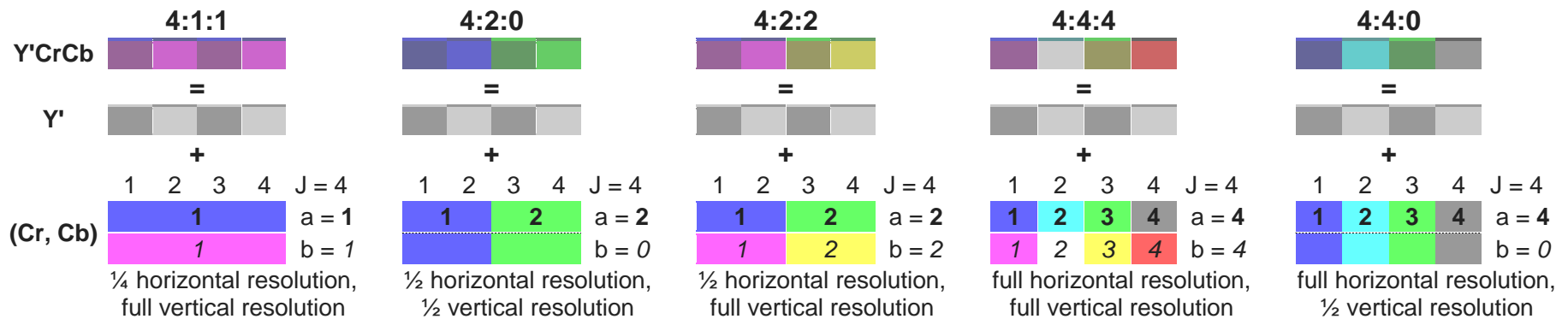


The CbCr plane at constant luma $Y'=0.5$

The subsampling scheme is commonly expressed as a three part ratio $J:a:b$ (e.g. 4:2:2) that describes the number of luminance and chrominance samples in a conceptual region that is J pixels wide, and 2 pixels high. The parts are (in their respective order):

- J : horizontal sampling reference (width of the conceptual region). Usually, 4.
- a : number of chrominance samples (Cr, Cb) in the first row of J pixels.
- b : number of changes of chrominance samples (Cr, Cb) between first and second row of J pixels.

This notation is not valid for all combinations and has exceptions, e.g. 4:1:0 (where the height of the region is not 2 pixels but 4 pixels, so if 8 bits/component are used the media would be 9 bits/pixel) and 4:2:1.



Video Compression

- Video compression is used to reduce transmission bandwidth
- Trade-off between compression and video quality
- Currently H.264 (MPEG-4 part 10 AVC) is most commonly used
- H.264 used in DVB-T, DVB-T2, DVB-C, DVB standards
- H.264 has multiple profiles – Main and High Profile most important
- High profile used in Blu-ray and DVB standard for HDTV
- H.265 (HEVC or MPEG-H part 2) new standard offering 50% more compression
- H.265 essential to reduce UHD transmission bandwidth

H.264 and H.265 How it works (Overview)

- Exploit spatial and temporal redundancies in video content
- Predict small areas (macroblocks) of picture then only transmit the difference
- YouTube video explains

<https://www.youtube.com/watch?v=Fawcboio6g4>

UHD

HDMI

Version comparison

Main Specifications

	HDMI Version				
	1.0–1.2a	1.3–1.3a	1.4–1.4b	2.0–2.0b	2.1
Maximum Data Rate ^[b]	4.95 Gbit/s	10.2 Gbit/s	10.2 Gbit/s	18.0 Gbit/s	48.0 Gbit/s

Video Format				HDMI Version / Maximum Data Rate				
Shorthand	Resolution	Refresh Rate (Hz)	Data Rate Required ^[a]	1.0–1.1	1.2–1.2a	1.3–1.4b	2.0–2.0b	2.1
				3.96 Gbit/s	3.96 Gbit/s	8.16 Gbit/s	14.4 Gbit/s	42.6 Gbit/s
720p	1280 × 720	24	576 Mbit/s	Yes	Yes	Yes	Yes	Yes
		30	720 Mbit/s	Yes	Yes	Yes	Yes	Yes
		60	1.45 Gbit/s	Yes	Yes	Yes	Yes	Yes
		120	2.99 Gbit/s	No	Yes	Yes	Yes	Yes

1080p	1920 x 1080	24	1.26 Gbit/s	Yes	Yes	Yes	Yes	Yes
		30	1.58 Gbit/s	Yes	Yes	Yes	Yes	Yes
		60	3.20 Gbit/s	Yes	Yes	Yes	Yes	Yes
		120	6.59 Gbit/s	No	No	Yes	Yes	Yes
		144	8.00 Gbit/s	No	No	Yes	Yes	Yes
		240	14.00 Gbit/s	No	No	No	Yes	Yes
		144	14.08 Gbit/s	No	No	No	Yes	Yes
		240	24.62 Gbit/s	No	No	No	No	Yes

4K	3840 × 2160	30	6.18 Gbit/s	No	No	Yes	Yes	Yes
		60	12.54 Gbit/s	No	No	No	Yes	Yes
		75	15.79 Gbit/s	No	No	No	No	Yes
		120	25.82 Gbit/s	No	No	No	No	Yes
		144	31.35 Gbit/s	No	No	No	No	Yes
		240	54.84 Gbit/s	No	No	No	No	Yes ^[b]
8K	7680 × 4320	30	24.48 Gbit/s	No	No	No	No	Yes
		60	49.65 Gbit/s	No	No	No	No	Yes ^[b]
		120	102.2 Gbit/s	No	No	No	No	Yes ^[b]

ULTRA HD PREMIUM™



The UHD Alliance was created with the consumer in mind providing information on premium UHD devices and content to deliver best in class entertainment.

The Alliance is also focused on helping consumers build a seamless, integrated and high-quality UHD ecosystem from end-to-end Premium UHD devices and content.

The UHD Premium Standard

- Minimum 2160x3840 resolution
- YCrCb 4:4:4, 4:2:2, 4:2:0
- HDR10 or Dolby Vision (10 or 12bit colour)

Conclusions and Discussion