Frontiers of video

• The evolution of digital video over more than 30 (!) years
• Image issues
• UHDTV and beyond - what comes next after HDTV?
The origins of digital video

CCIR-601 signal format introduced in 1982

- 525 / 625 lines
- Full bandwidth digital component video
- 27 Msamples per second ‘common data rate’
- Connector with multicore cable required

CCIR-656 interface introduced in 1986

- Serial digital interface at 270Mbps.
- Single coaxial cable and BNC connectors.

CCIR : Comité Consultatif International pour la Radio
Key ITU-R Recommendations on image formats

1982: BT. 601 Studio encoding parameters of digital television for standard 4:3 and wide screen 16:9 aspect ratios

1993: BT.709 Parameter values for the HDTV standards for production and international programme exchange

1995: BT.1201 Extremely high resolution imagery

2008: BT.1543 1280 x 720, 16:9 progressively-captured image format for production and international programme exchange in the 60 Hz environment

2009: BT.1847 1280 × 720, 16:9 progressively-captured image format for production and international programme exchange in the 50 Hz environment

2012: BT.2020 Parameter values for ultra-high definition television systems for production and international programme exchange

2014: BT.2050 Use of UHDTV image systems for capturing, editing, finishing and archiving high-quality HDTV programmes
Let’s not completely forget 3D TV!

BT.2293-1 (2014) Principles for the comfortable viewing of stereoscopic three-dimensional television (3D TV) images
UHDTV - production and international programme exchange

Rec. ITU-R BT.2020

- Higher spatial resolution - multiples of 1920 x 1080
  - 3840 x 2160
  - 7680 x 4320
- Aspect ratio 16:9
- No interlace!
- Frame rates up to 120 Hz
- Wide colour gamut
- 10 or 12 bits per sample
The trend towards higher spatial resolution

UHDTV 7680x4320

UHDTV 3840x2160

HD

SD
Comparing resolution of SD and HDTV

SD (720x540 & 720x576) 4:3 aspect ratio

16:9 aspect ratio HD (1920x1080)
Comparing resolution of HDTV and UHDTV

HDTV 1920x1080

UHDTV 3840x2160
Image quality

More than just resolution

- Resolution
- Colour volume (gamut)
- Bit depth (quantisation)
- Dynamic range
- Frame rate

- Resolution:
  - 24/25/30P
  - 60i/50i
  - 60p/50p
  - 120p/100p

- Colour volume (gamut):
  - BT.2020
  - BT.709

- Bit depth (quantisation):
  - 8bit
  - 10bit
  - 12bit

- Dynamic range:
  - 12bit
  - 10bit
  - 8bit
Wider colour gamut

ITU-R BT.2020

ITU-R BT.709
Image quality

More than just resolution

Resolution

Dynamic range

Colour volume (gamut)

Bit depth (quantisation)

OLED 1 million :1

LCD 1,000:1

BT.2020

BT.709

8bit

10bit

12bit

24/25/30P

60i/50i

60p/50p

120p/100p

Many new displays are much brighter

LCD 1,000:1

BT.709

BT.2020

OLED 1 million :1

8bit

10bit

12bit

24/25/30P

60i/50i

60p/50p

120p/100p

More than just resolution

Many new displays are much brighter
Opto-Electrical Transfer Function (OETF)

UHDTV OETF has same characteristics as for HDTV (BT.709)

- Designed for a reference viewing environment using displays with peak brightness of 100 cd m$^{-2}$
High dynamic range and high brightness display

Using the conventional transfer function (OETF) representing high scene brightness on high peak brightness displays would show visible contouring - unless more bits per sample are used to represent the signal.

**A new OETF is required!**
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UHDTV is coming!

HDR / Extended Image Dynamic Range Television (EIDRTV) is also coming!

• Compatibility with existing broadcast operational practice must be taken into account
  – conversion between colour gamuts of BT.709 and BT.2020
  – conversion/coexistence between standard dynamic range and high dynamic range
  – any impact on bit-rate for delivery to the home must be understood

• Brighter highlights – adds ‘sparkle’ and even more realism
  – NB: consider display brightness vs. power consumption vs. viewing comfort

Work towards [preliminary] draft new Recommendation ITU-R BT.[EIDRTV]

• Working Party 6C and Rapporteur Group RG-24
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Don’t forget the subjective impact of audio on perceived image quality!
Thank you!

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