ICC HDR EXPERTS DAY

CHOOSING CONVERSIONS FOR HDR TV

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FIRST, LET'S LOOK AT THE CONSTRAINTS OF LIVE TELEVISION

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HDR FORMAT MUST ACCOMMODATE REAL WORLD REQUIREMENTS

- Uncontrolled viewing environment at home
  - Device brightness and ambient lighting differ
- Uncontrolled venue lighting
- HD still main deliverable
- HDR OB trucks often 3rd party
  - IP or SDI Video
  - Multiple vendors for cameras/converters

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PRODUCTIONS ARE COMPLEX

- A production will have multiple input formats
  - HDR cameras
  - SDR cameras
  - Archive content
  - Action replays
  - Uncompressed graphics
  - Host broadcaster feeds (major events)

BBC RESEARCH & DEVELOPMENT

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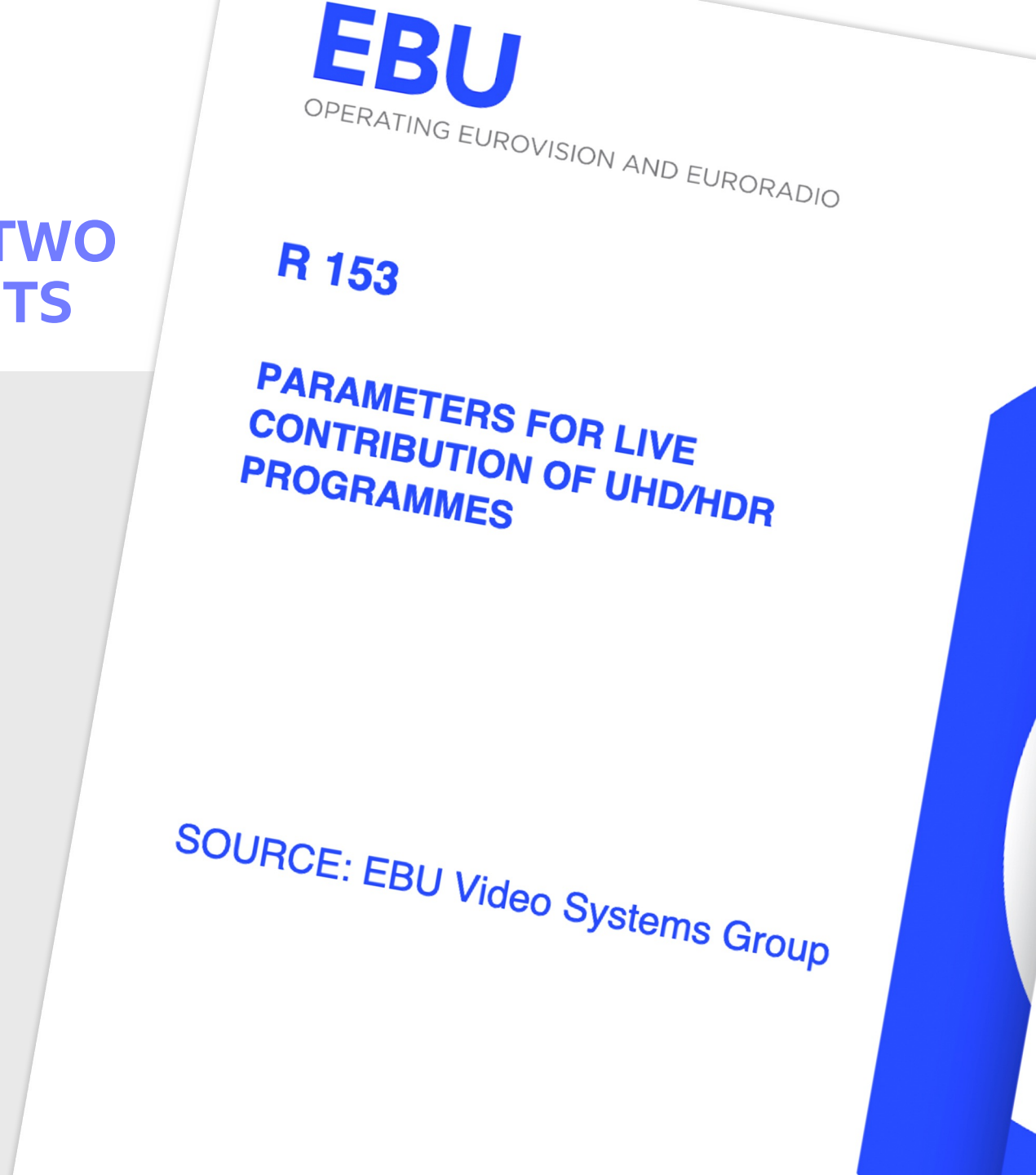
SINGLE PRODUCTION DELIVERS TWO STANDARDS COMPLIANT OUTPUTS

- UHD - ITU-R BT.2100 HLG
- HD - ITU-R BT.709 derived from UHD
- No degradation for HD viewers



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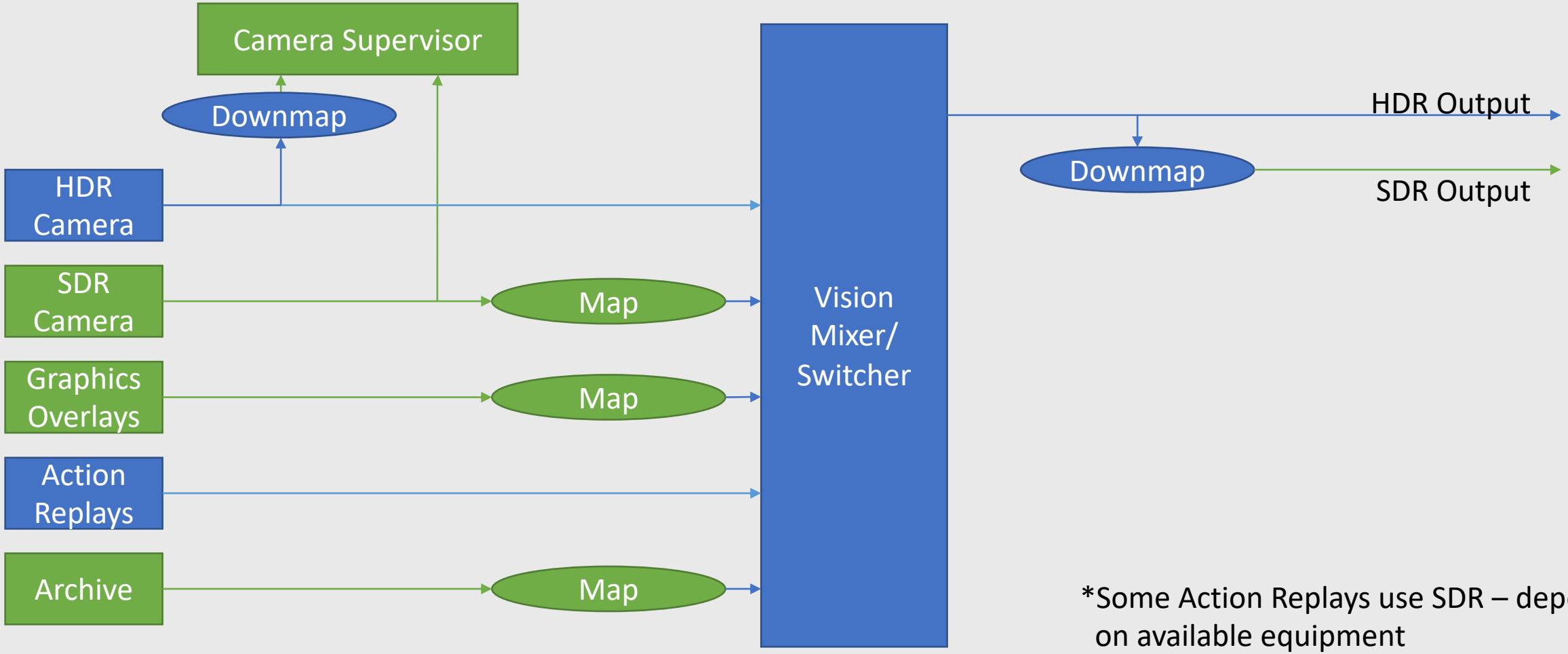
A COMMON WORKFLOW EMERGING



*Some Action Replays use SDR – depends on available equipment

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CREATING CONVERSION TRANSFORMS

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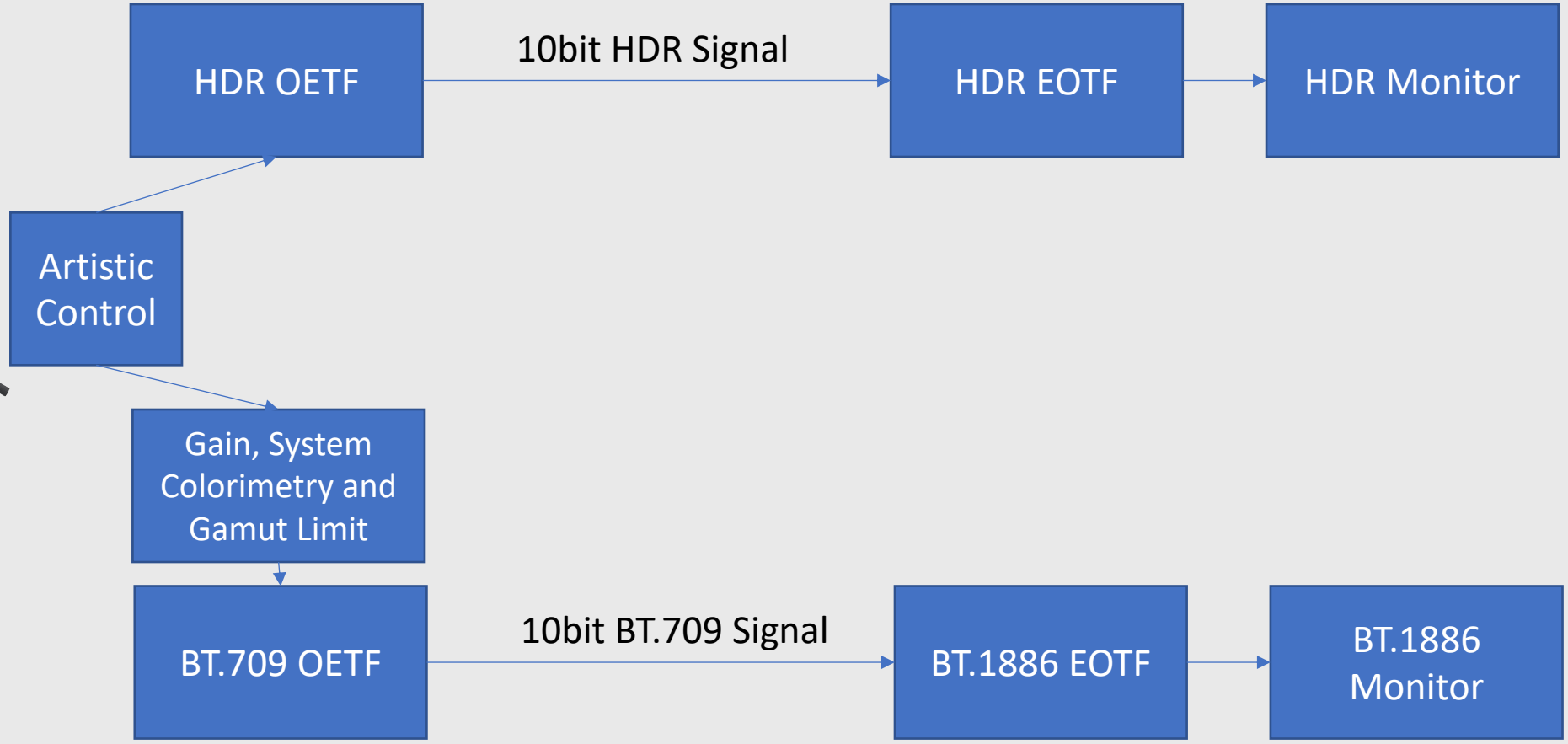
WHAT AN HDR CAMERA DOES



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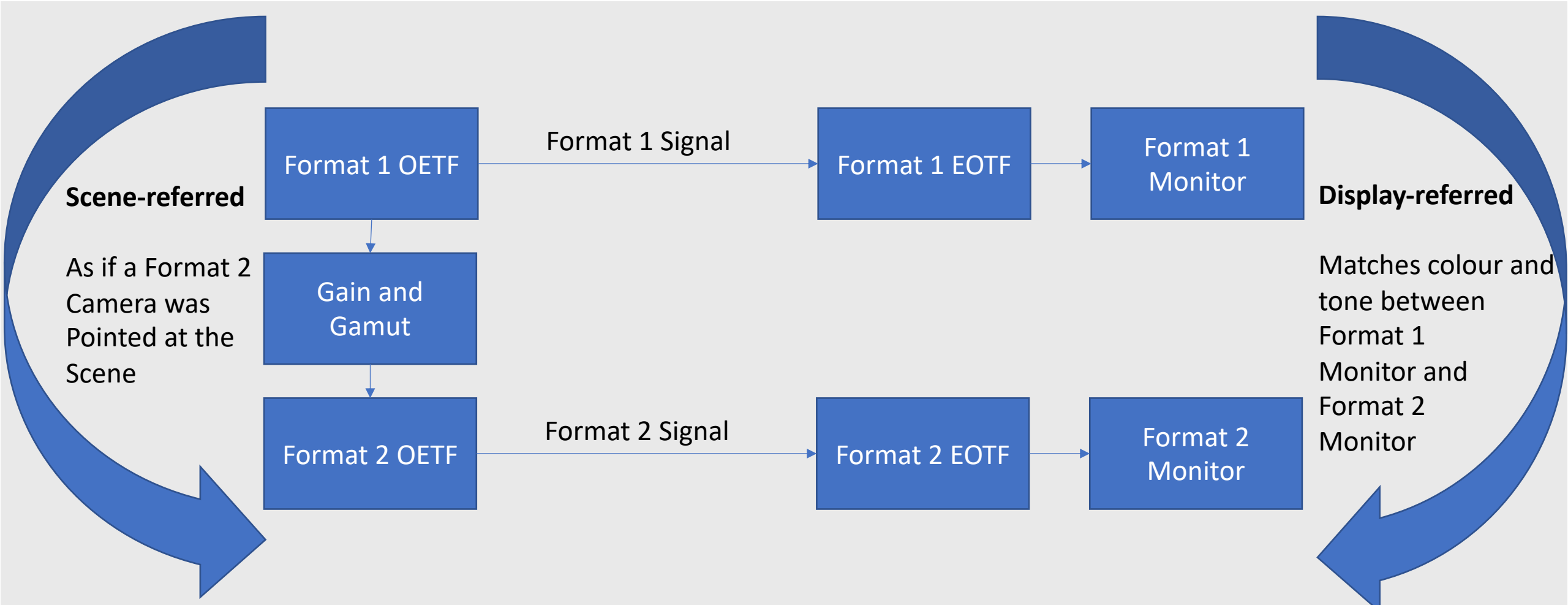
SIMPLIFY TO DESIGN TRANSFORMS



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SIMPLIFY TO DESIGN TRANSFORMS

Display Referred

NB As these are Pseudo-Monitors,
choose luminance to simplify conversion

Scene Referred

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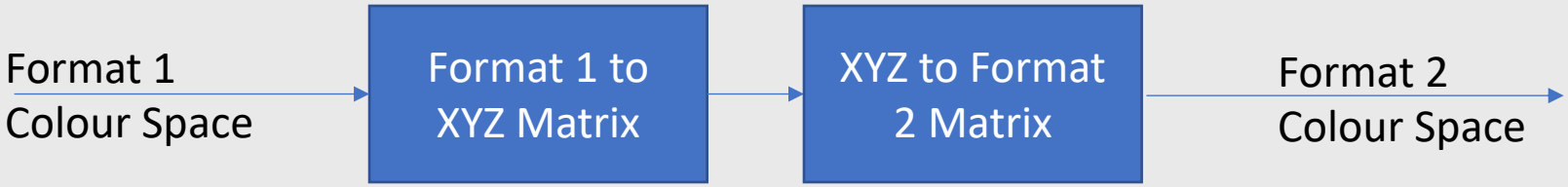
COLOUR SPACE IS EASY



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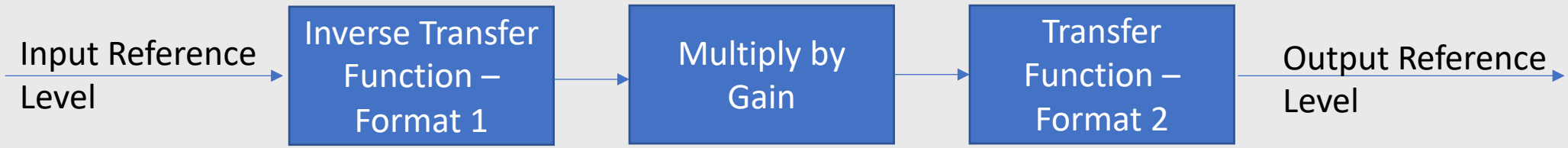
GAIN IS EASY



Input and output reference levels and the transfer functions are defined, therefore gain can be calculated

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AN EXAMPLE FROM W3C

```
function convertExtendedSRGBtoREC2100HLG(r, g, b) {
  const systemGamma = 1.0;
  const linearLightScaler = 0.26496256042100724;

  const r1 = srgb_eotf(r);
  const g1 = srgb_eotf(g);
  const b1 = srgb_eotf(b);

  const [r2, g2, b2] = matrixXYZtoBT2020(matrixSRGBtoXYZ(r1,g1,b1));

  const r3 = linearLightScaler * r2;
  const g3 = linearLightScaler * g2;
  const b3 = linearLightScaler * b2;

  const [r4, g4, b4] = hlg_inverse_ootf(r3, g3, b3, systemGamma);
  const [r5, g5, b5] = hlg_oetf(r4, g4, b4);

  return [r5, g5, b5]
}
```

Format 1 Signal

Maps sRGB Reference White to HLG Reference White

Pseudo HLG Display of HLG Reference White chosen to match sRGB standard 80 cd/m^2

Shadows and
Mid-Tones automatically match

Format 1 EOTF

Colour Space Conversion

Gain

Format 2 Inverse EOTF

Format 2 Signal

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TONE MAPPING – HIGHER TO LOWER DYNAMIC RANGE E.G. HLG TO BT.709

- Constrained output
- Must look like SDR target signal
  - Mid Grey – 50%
  - Grass - 45 - 55%
  - Light Skin Tone – 70 to 75%

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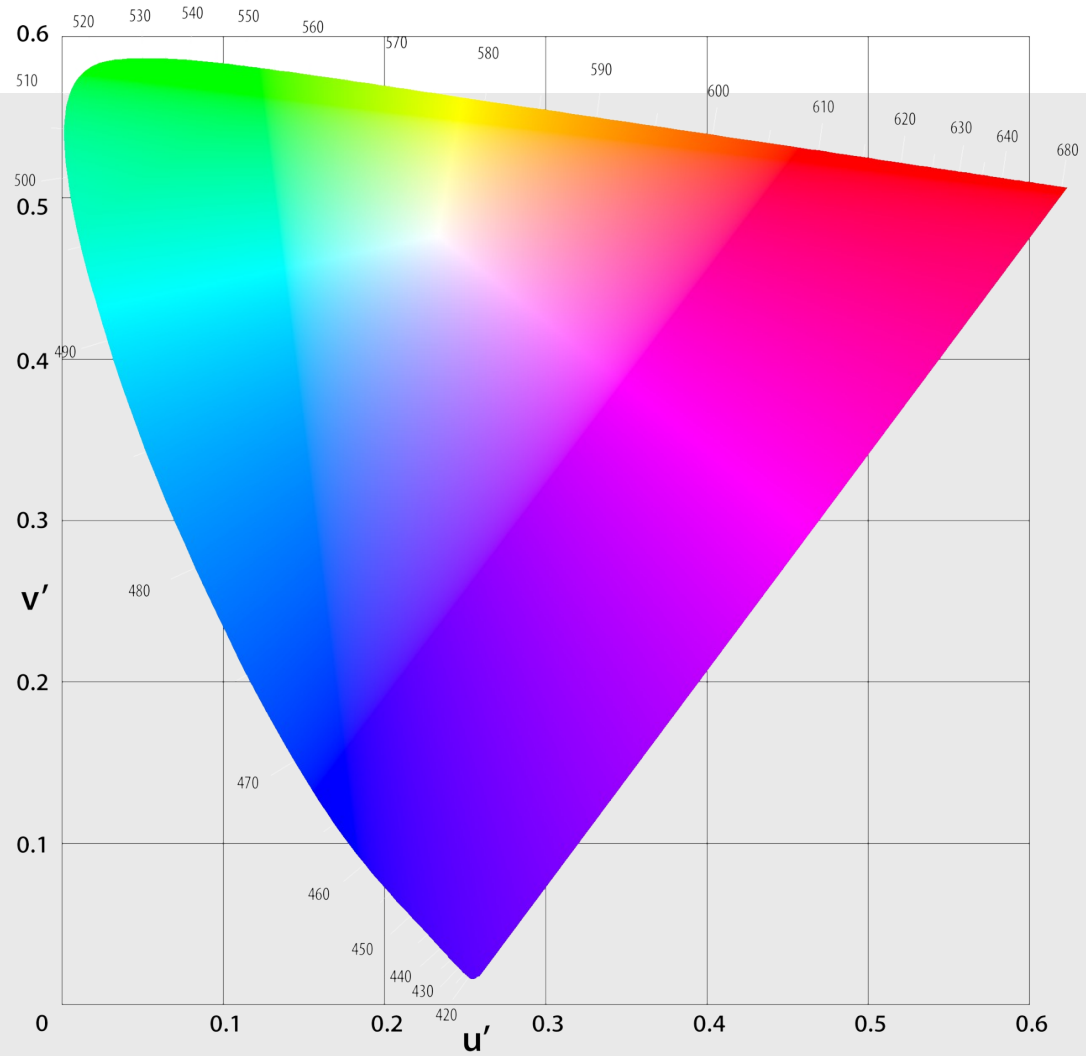
GAMUT REDUCTION

- Many options:
  - Maximise Saturation
  - Minimise Hue Distortion
  - Minimise Chrominance Distortion
  - Match a Model of the Human Visual System
- Maintain Memory Colours (Grass, skin, sky etc.)
- Maintain Brand Colours



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ITU RECOMMENDS

HLG Table
(similar exists for PQ)

Signal			Conversion Type		SDR to HLG		HLG to SDR		PQ to HLG
			Scene-light	Display-light	Direct mapping	Up-mapping	Hard clip	Down-mapping	Trans-coding
Graded Content		SDR graded inserts		✓	✓ (1)	✓ (2)			
		PQ graded inserts		✓					✓
Cameras	To switcher	SDR camera (relaxed clippers for BT.709)	✓			✓			
		PQ camera	✓						✓
	To shading	HDR camera with SDR shading	✓				✓		
		SDR camera with HDR shading	✓			✓			
Graphics		SDR matching colour branding		✓	✓				
		SDR matching in-vision signage	✓		✓				
SDR Output(3)		SDR complete programme		✓				✓	
		SDR for downstream mixing with SDR cameras	✓					✓	

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THE (HOPEFULLY NEAR) FUTURE

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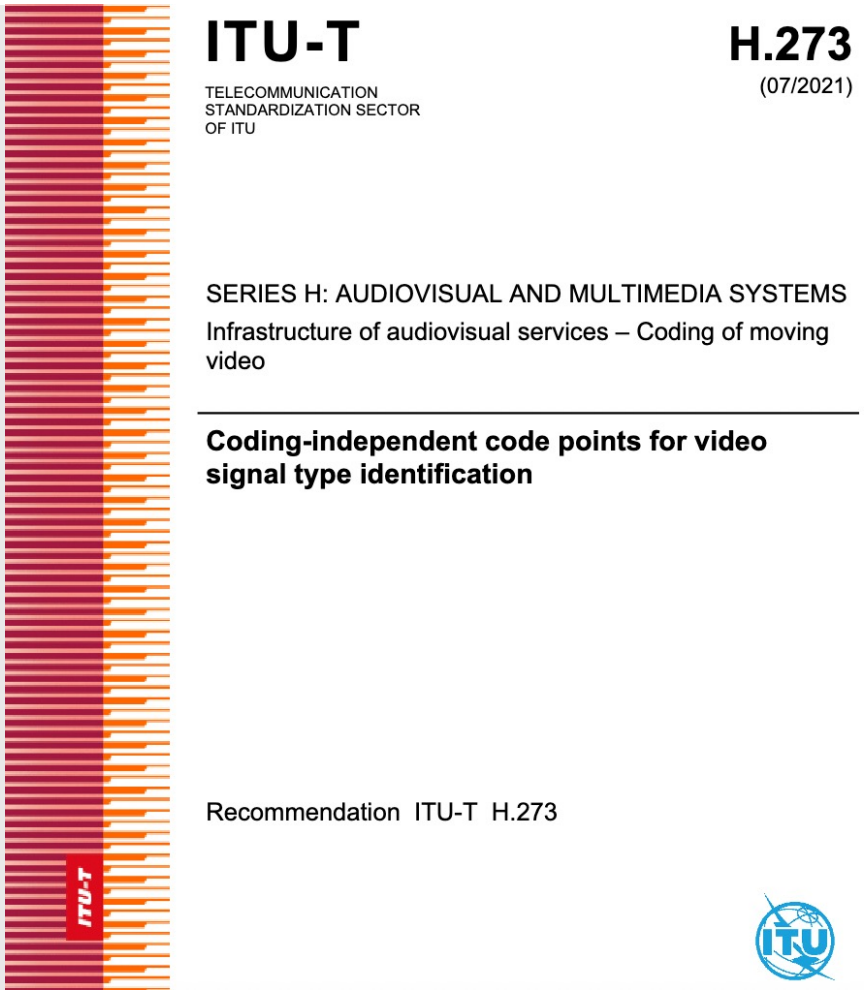
HDR GRAPHICS

- Currently in W3C Working Draft for PNG
  - Borrowed “code points” from ITU
- Allows HDR production of:
  - Graphics
  - Virtual reality sets
  - Logos, etc.



ITU-T

TELECOMMUNICATION STANDARDIZATION SECTOR OF ITU

H.273

(07/2021)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Coding of moving video

Coding-independent code points for video signal type identification

Recommendation ITU-T H.273

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DYNAMIC TRANSFORMS

- Dynamic Transforms
  - Spatial Adjustment
  - Temporal Adjustment
- Better deal with the effect of highlights changing perception of shadows
- Allow greater exploration of colour volume

- BUT!
  - Graphics must not change in perceived brightness or colourfulness
  - Effect on underlying video should not differ perceptually due to graphics presence

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THANK YOU

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www.bbc.co.uk/rd/projects/high-dynamic-range