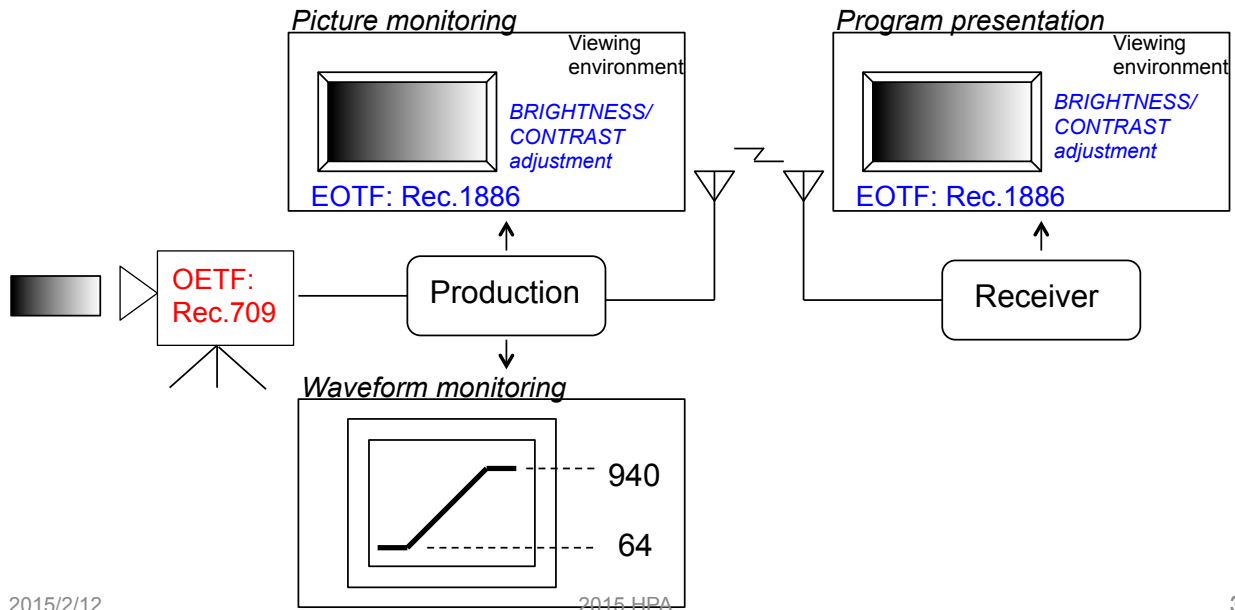

Roles of non-linear coding of television image: Should be redefined?

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NHK

Background

- New standard and proposals for non-linear transfer functions for HDR
- Non-linear transfer functions themselves does not make HDR happen.
- Only quantization step distribution is being talked in HDR study.
- Some roles of them were not originally intended and are not recognized well till now.

Current television system



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EOTF role



- Rec.1886 $L = a(\max[(V + b), 0])^\gamma$ Gamma characteristics
 - CONTRAST adjustment
 - BRIGHTNESS adjustment
- Bit rate reduction
 - By changing the quantization step to make the adjacent step contrast ratio perceptually more efficient.
- Display adjustment
 - Television signal corresponds to RELATIVE display luminance
 - Code 64 for BLACK under each viewing environment
 - Code 940 for WHITE under each viewing environment

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Original OETF role: Gamma compensation



- Not needed anymore for compensate CRT display physics

but

- How about the happy coincidences?

Happy coincidence 1: Noise/Bit rate reduction

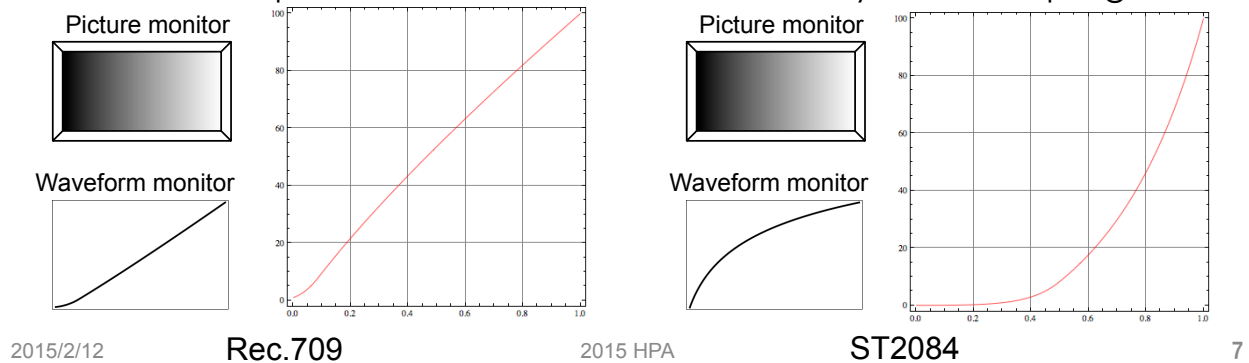


- Analog era
 - Pre-emphasis at camera end /de-emphasis at display end
 - compress the transmission path noise in dark portion
 - to improve the perceptible SNR.
- Digital era
 - Changing the quantization step distribution so that
 - the luminance steps in dark portion are smaller than in bright portion
 - makes the quantization error less visible.

Happy coincidence 2: Perceptual linearity



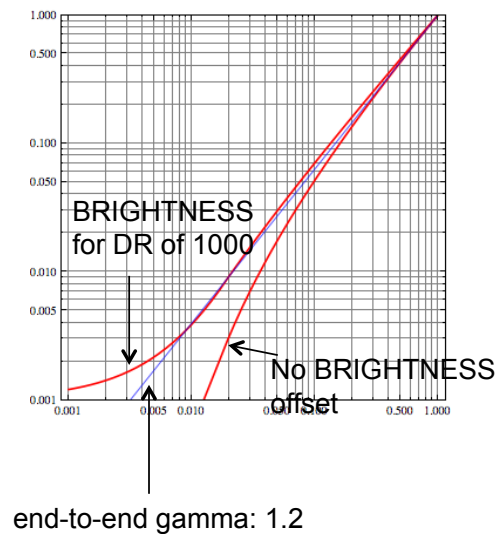
- Relationship between video level and perceived lightness
 - i.e., OETF and CIE L* lightness
- Enables wave-form based quality control/ handling of OETF-encoded signals
 - indispensable to ensure the consistency between programs



Happy coincidence 3: Linear portion



- Linear portion of OETF is used to avoid excessive camera noise.
- This makes the end-to-end characteristic to deviate from a constant end-to-end gamma.
- BRIGHTNESS control in EOTF compensates the deviation.



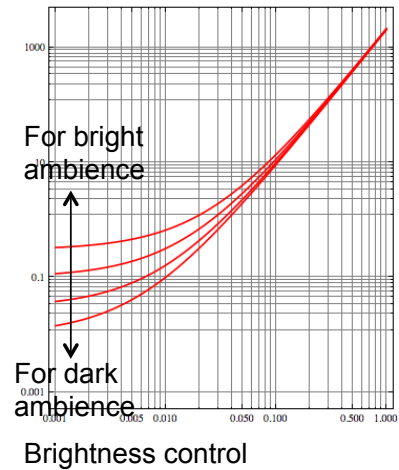
Happy coincidence 4: End to end gamma



- It is believed that end-to-end gamma of about 1.2 is suited for television color appearance.
 - Displayed absolute luminance is almost always lower than captured scene.

- BRIGHTNESS control effectively changes the end-to-end gamma.

- The change seems in accordance with color appearance model.
 - The darker ambience, less BRIGHTNESS and larger gamma.



Summary



Standards	Rec.709/1886	ST2084
Adaptation to viewing environment	Yes: BRIGHTNESS, CONTRAST	No
Bit rate reduction	Yes: Gamma	Yes: PQ curve
Perceptual linearity	Yes	No
Linear portion in OETF	Yes	No

Summary



Standards	Rec.709/1886	ST2084
Adaptation to viewing environment	Yes: BRIGHTNESS, CONTRAST	No
Bit rate reduction	Yes: Gamma	Yes: PQ curve
Perceptual linearity	Yes	No
Linear portion in OETF	Yes	No

Concept	Relative approach	Absolute approach
Assumed viewing environment	Diversified, usually different from mastering	Desirable to be same as that of mastering
How to make HDR happen	Specify "black", "white", highlight relatively	Specify display luminance directly

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Thank you!

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