The World’s First 8K/4K “Regular” Broadcasting

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NEC Corporation

Content

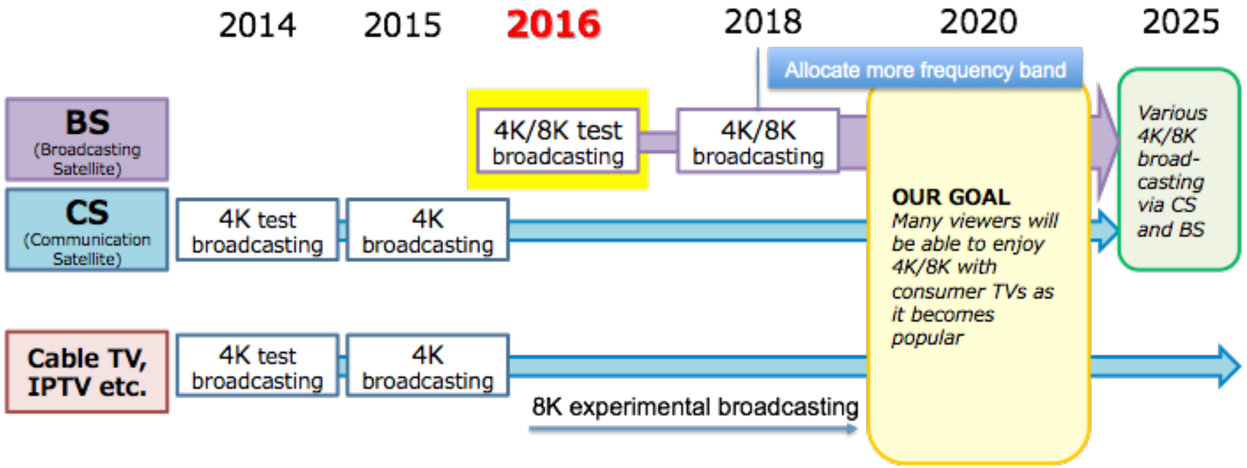
- Introduction
- System overview
- Production/Post-production equipment
- Playout control/Transmission system
- Receiver
- Standards/Guidelines for HDR
- Future prospect

Introduction

History and Roadmap
Test broadcasting scheme

History and Roadmap

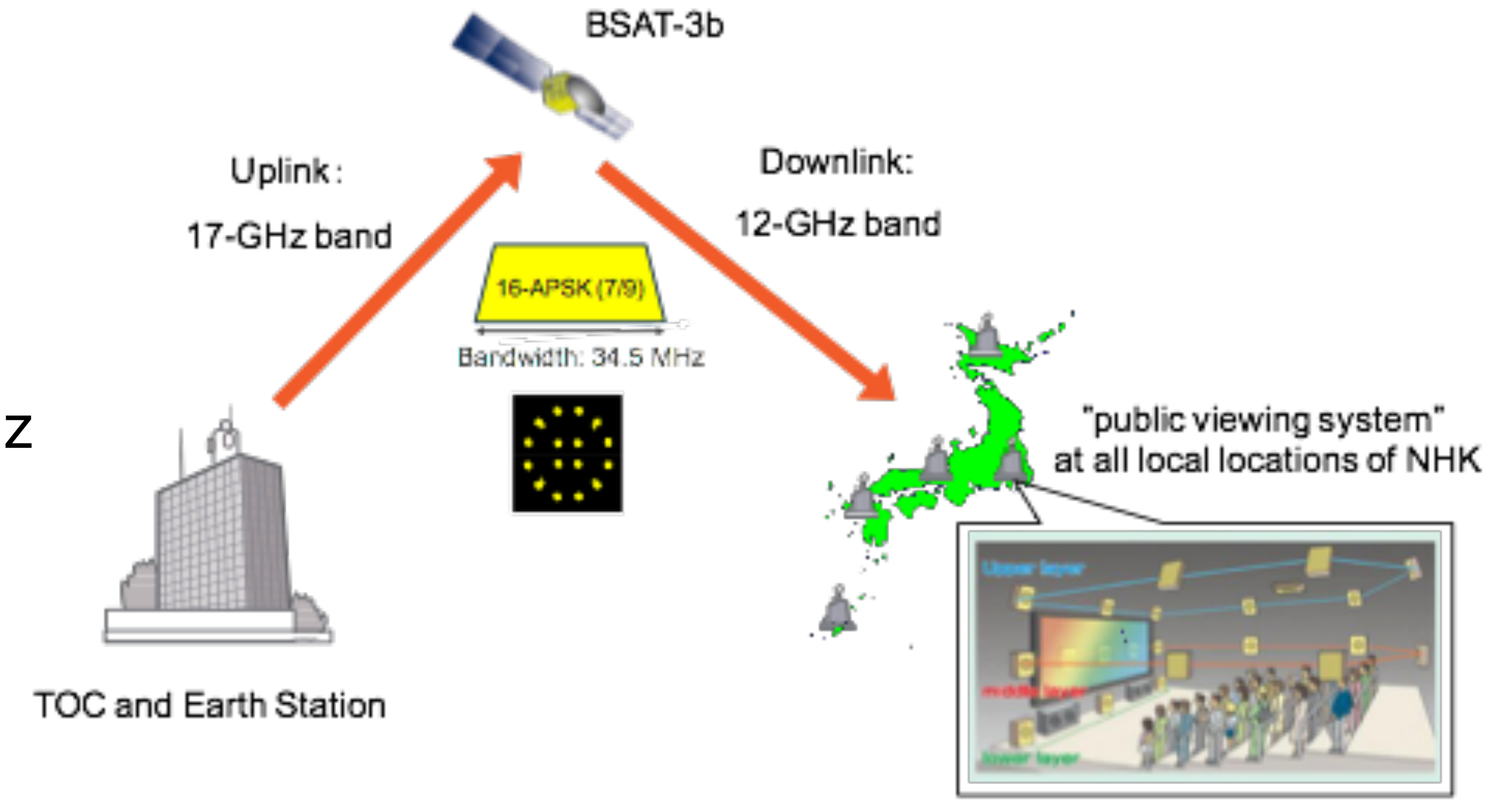
- 1995 NHK started R&D on UHDTV.
- 2002 8K first public demo at NHK STRL
- 2005 Public viewing at Expo 2015 Aichi
- 2006 First appearance at NAB show
- 2012 Rec. ITU-R BT.2020
- 2012 Showcasing at London Olympics
- 2013 National roadmap
- 2016 Test broadcasting via satellite
- 2016 Showcasing at Rio de Janeiro Olympics



http://www.soumu.go.jp/menu_news/s-news/01ryutsu11_02000058.html

Test broadcasting scheme

- Broadcasters
  NHK Aug. 1, 2016
  A-PAB* Dec. 1, 2016
- BSAT-3
- BS channel/transponder 17
  12.03426 GHz BW:34.5 MHz
- Service channel: 8K/60p**
  1ch, or 4K/60p** 2ch
- Commercial receivers are under development.

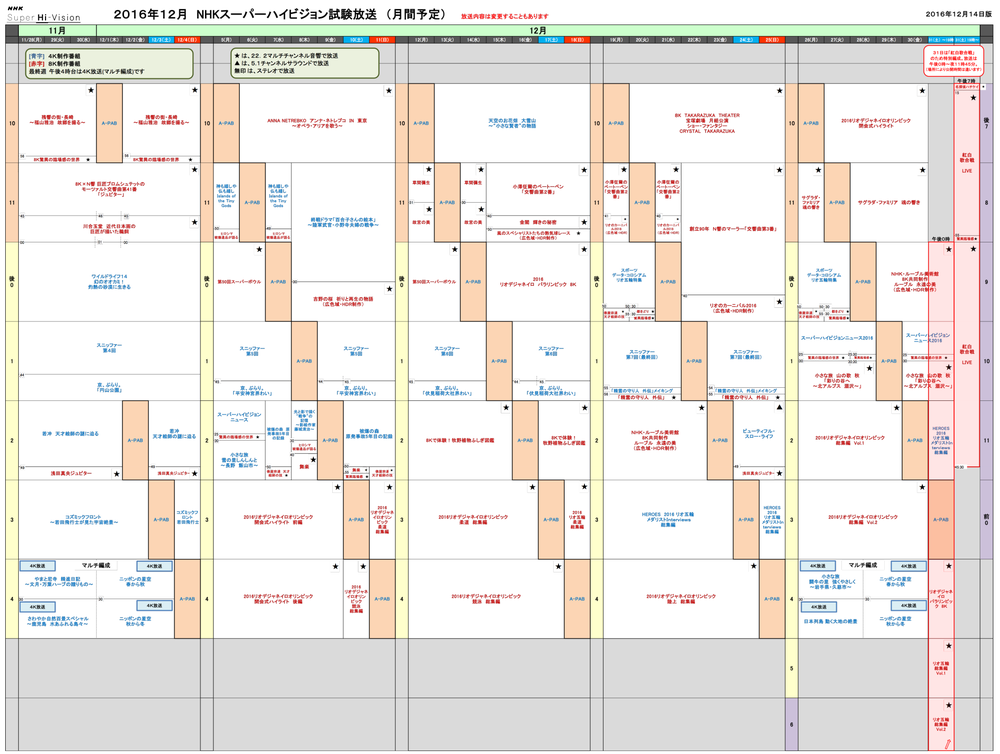


Report ITU-R BO.2397-0 Satellite transmissions for UHDTV satellite broadcasting

* The association for Promotion of advanced broadcasting services
** with WCG, HDR, future extension for HFR

Regular broadcasting

- 7 hours daily operation
  NHK: 6 hours, A-PAB: 1 hour
- A number of programs in diversified genre are to be provided.
- Sets of program production equipment are required.
- A play-out control system is required.



An example of monthly program table

System overview

Core technologies
Format
Encoding
Transmission

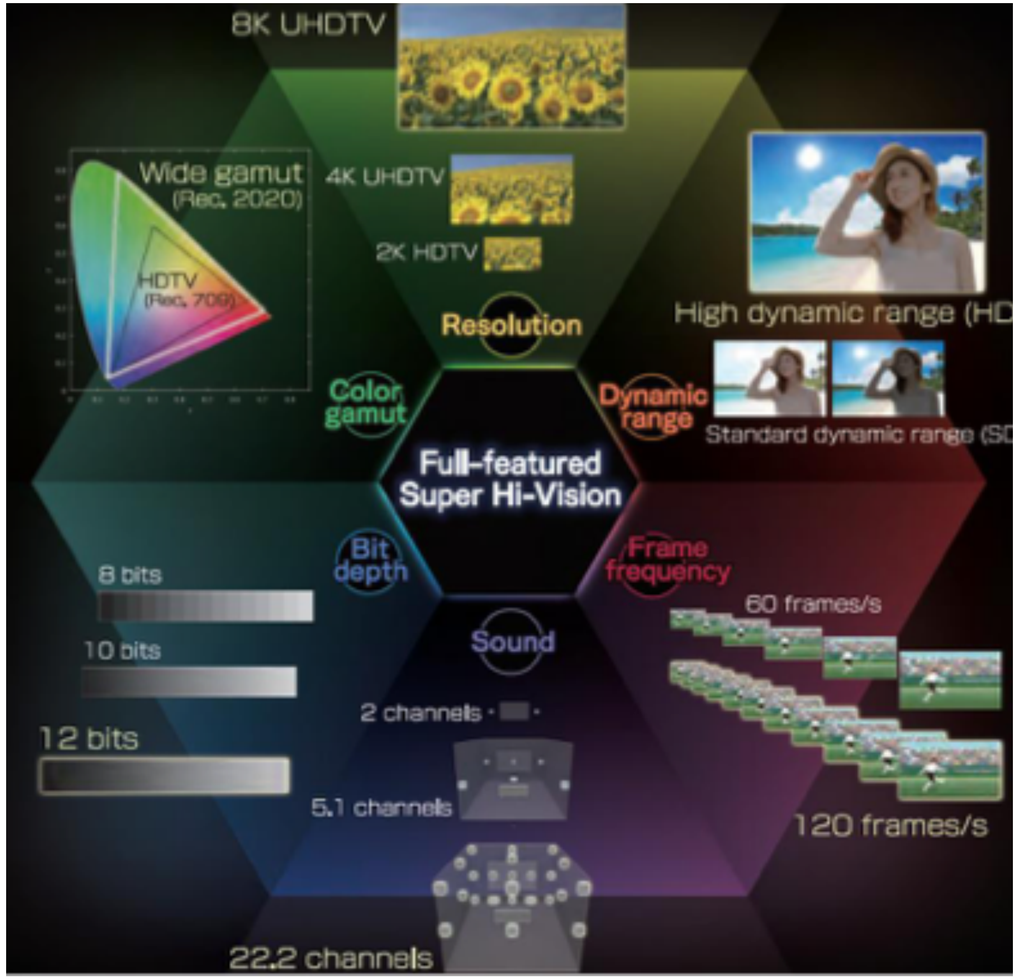
Core technologies

layer		Current HD service	8K/4K test broadcasting	Standard
Format	Video	2K/60i, 8bit	**8K/60p*, 4K/60p*, 10bit**	Rec.2020
	Audio	5.1, stereo, mono	**22.2, 7.1, 5.1, stereo**	Rec.2051
Coding	Video	MPEG-2 Video	**HEVC|H.265**	
	Audio	MPEG-2 AAC	**MPEG-4 AAC (LC profile)**	
	MUX	MPEG-2 TS	**MMT TLV**	
Transmission	Modulation	TC8PSK	**16APSK**	Rec.2098 (ISDB-S3)
	FEC	CC+RS (2/3)	**LDPC+BCH (7/9)**	
	Rolloff	0.35	**0.03**	
	Capacity	52 Mbps typ.	**100 Mbps typ.**	

* with WCG, HDR, future extension for HFR

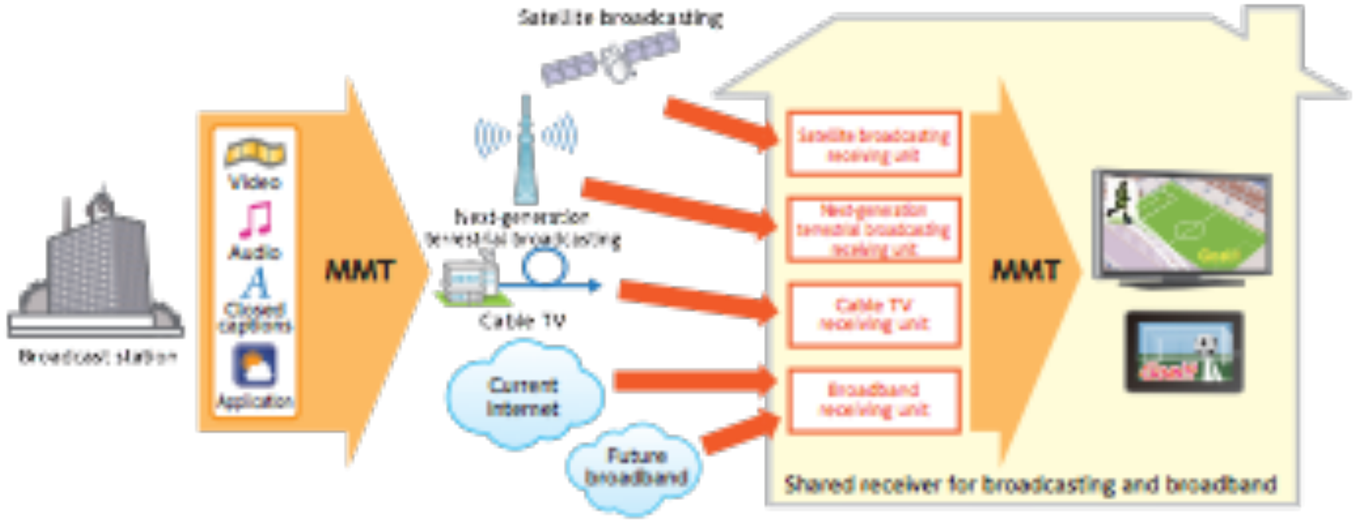
Format layer

- An ultimate form of two-dimensional television
- ITU-R Rec. BT.2020
  - UHD image: 7680 x 4320 (8K)
  - High frame rate: 120 Hz ready
  - Wide color gamut
  - Bit depth: 10
- ITU-R Rec. BT.2100
  - High dynamic range: Hybrid Log-Gamma
- ITU-R Rec. BS.2051
  - 22.2 multi-channel audio



Encoding layer

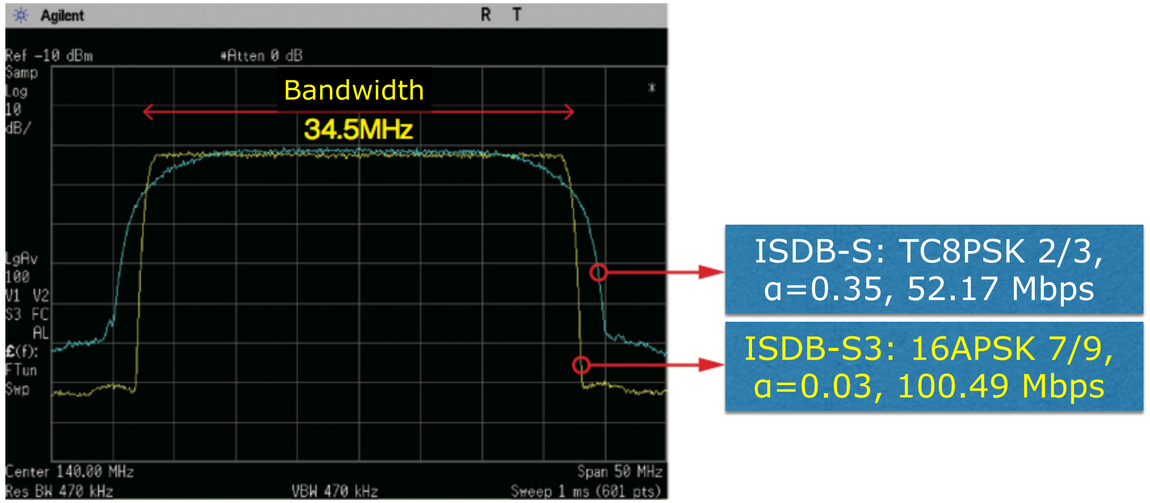
- HEVC
  - High compression efficiency
  - 72 Gbps -> 85 Mbps
- MPEG-4 AAC
  - 22.2 ch -> 1.4 Mbps
- MMT
  - Synchronization
    - multiple transmission paths
    - multiple display devices
  - Multiplexing
  - Reliability



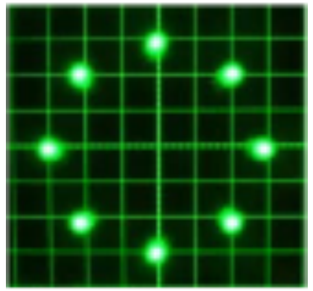
http://www.nhk.or.jp/strl/onepoint/8kmmt_e.html

Transmission layer

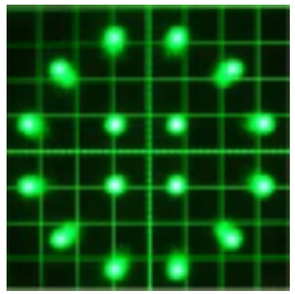
- **ISDB-S3**: The state-of-the-art satellite transmission system specified in ITU-R Rec. BO.2098
- Large transmission capacity: 100 Mbps
  - Low Roll-off factor :0.03
  - Introduction of LDPC for FEC
  - 16 APSK
- Rain fade survivability
- Stable reception for low C/N
- Transmission of variable length packets
- Robustness against satellite transponder nonlinearity
  - Worst-month service availability of 99.7% using a 45 cm receive antenna in Tokyo



ISDB-S TC8PSK



ISDB-S3 16APSK



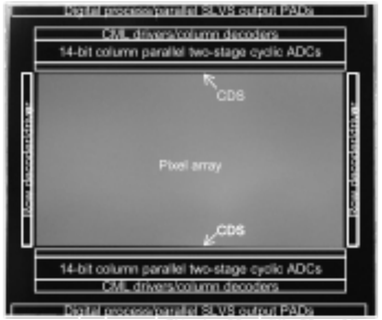
Report ITU-R BO.2397-0 Satellite transmissions for UHDTV satellite broadcasting

Production/Post-production equipment

Camera
Display
Audio
Recorder
OB vans
Post-production rooms

Camera

- Image sensor



Chip size: 30 mm(H) × 26 mm(V)

Image size	Super 35 mm
Total pixels	7696 (H) x 4332 (V)
Active area	24.6 mm (H) x 13.9 mm (V)
Pixel size	3.2 μm x 3.2 μ m
Bit depth	14 bit
Electronic shutter	Rolling
Signal output	SLVS 16 ch.
Package	816pin LGA
Power consumption	below 3 W

Yasue, T., et al. (2016). "A 1.7-in, 33-Mpixel, 120-frames/s CMOS Image Sensor With Depletion-Mode MOS Capacitor-Based 14-b Two-Stage Cyclic A/D Converters." Ieee Transactions on Electron Devices **63**(1): 153-161.

- Camera systems

Handy type

Dockable type

Imaging	33Mpixel single-chip
Output	8K/59.94P, 4K/59.94P, HD/59.94i
Performance	F8@2000 Lux SNR 60dB
Functions	4K view finder Focus assist Auto chroma-aberration compensation

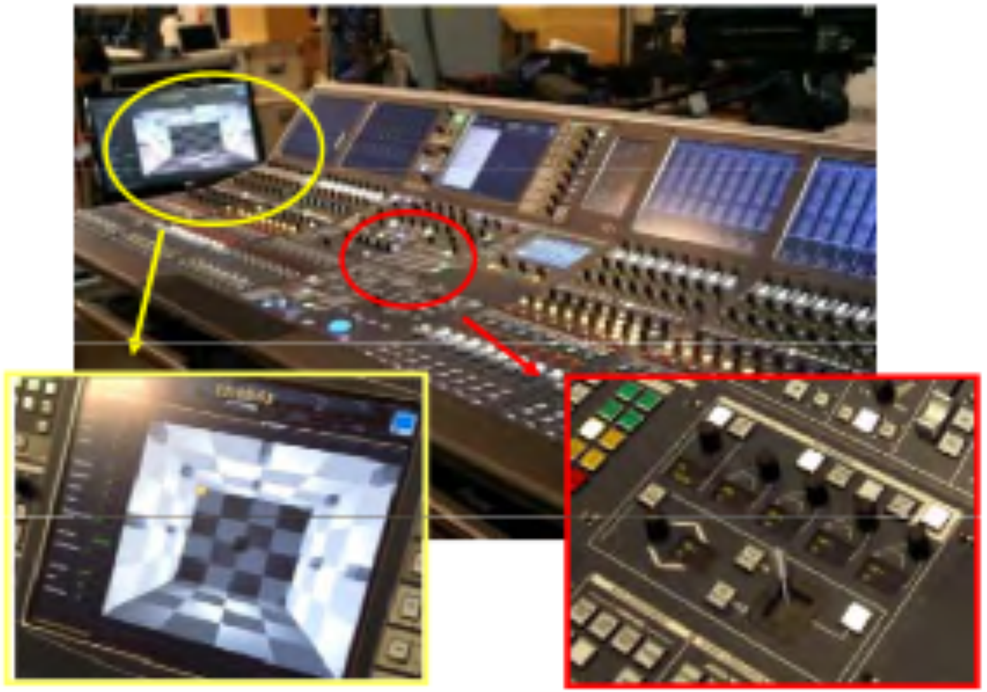
三橋政次 (2017). "実用的な8K単板カメラシステムの開発." 映像情報メディア学会誌 **71**(1): J51-J55.

Displays for monitoring

Purpose	Size/Type	Resolution/HDR
Main@Studio, Editing room, etc.	85” LCD	8K, HLG
Main@OB van	55” LCD	8K, HLG
Video Engineer, preview	17.3” LCD	8K, HLG
Video Engineer, Preview	30” OLED	4K, HLG
Camera VF	9.6, 12” LCD	4K, SDR

Audio

- 22.2 one-point microphone (upper left) to acquire sounds from 16 directions
- Live production mixer with 1000 tracks and 3D panning I/F
- Signal processor for headphone monitoring (upper right)



西口敏行, et al. (2015). "8Kスーパーハイビジョンのための22.2マルチチャンネル音響制作システム." 放送技術 **2015**(7): 153-157.

Recorder

- Second generation for more practical use
  - Reduced in size and power consumption
  - 4K compression technology applied
  - Multi-format output

Input signal	8K: 3G-SDI x 8
Output signal	8K: 3G-SDI x 8
	4K: 3G-SDI x 4
	HD: HD-SDI
Compression	AVC-Intra 4K/10bit
Media	8K: Memory card x 4
	HD: Memory card x 1
Audio	SDI embedded /MADI
Capacity	65 min. (256GB x 4)
Size (mm^3)	W432 x H176x D500
Weight (kg)	18
Power consumption (W)	152

市川健一郎, et al. (2015). "8Kスーパーハイビジョン用コンパクト圧縮収録再生機." 放送技術 **2015**(11): 66-70.

OB vans

8K Super Hi-Vision OB vans

SHC-1

SHC-2

Size (m^3)	L11.93 x W2.49 (+1m extension) x H3.33
Switcher/ router	SHC-1: SH-VS110 / NV-8280
	SHC-2: XVS-N8K / NV-8280
Production room	Main + Sub
VE room	18 Rack + Operation space 10 cameras, 4 replay SSDs, 4 recorders

宮崎正之, et al. (2015). "BKスーパーハイビジョン中継車「SHC-1、SHC-2」の開発." 放送技術 **2015**(12): 159-164.

Audio production vans

TA-1

SA-1

	TA-1	SA-1
Size (m^3)	L12.0 x W2.49 (+1.3 m extension) x H3.68	L11.5 x W2.49 (+1.3 m extension) x H3.49
Mix room	2.7 m Hight 22.2 ch audio	2.2 m Hight 22.2 ch audio
Mix console	mc2 66 MK2	NT-900

崎山剛, et al. (2015). "22.2マルチチャンネル音響対応 音声中継車の整備." 放送技術 **2015**(11): 71-74.

Post-production rooms

- 8K Video
  - Editing, image-synthesizing
  - Color grading (HDR capable)
  - Telop work
  - 85” Video monitor
  - Binaural audio monitor
  - 22.2 ch headphone

Sakiyama, T., et al. (2016). 8K-UHDTV Production Equipment and Workflow which Realize an Unprecedented Video Experience. SMPTE 2016 Annual Technical Conference and Exhibition.

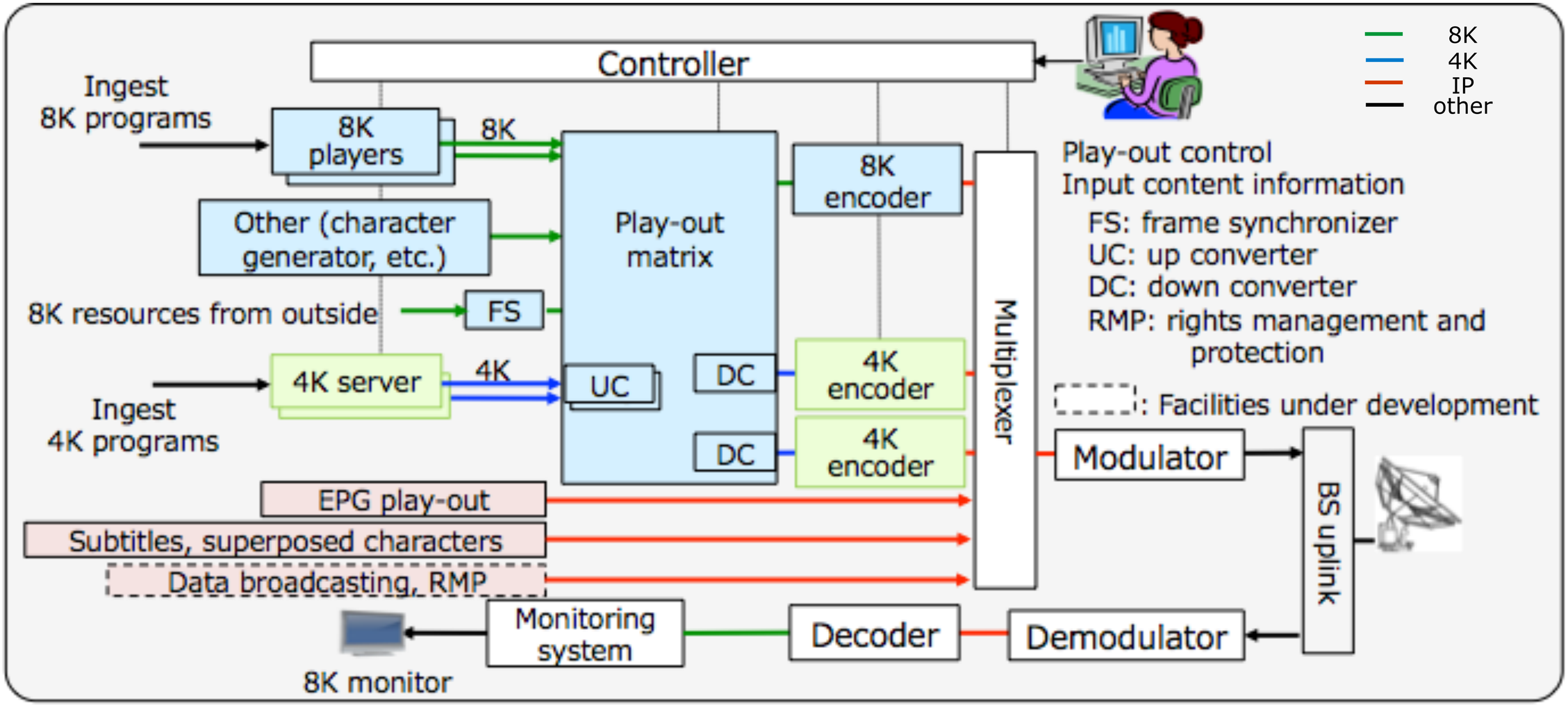
- 22.2ch Audio
  - DAW
  - MADI I/F
  - 22.2, 5.1, stereo
  - Audio-transparent screen
  - 8K projector
  - Listening environment

Sawaya, I., et al. (2015). "Dubbing Studio for 22.2 Multichannel Sound System in NHK Broadcasting Center." AES 138th Convention: Convention Paper 9327.

Playout control/Transmission system

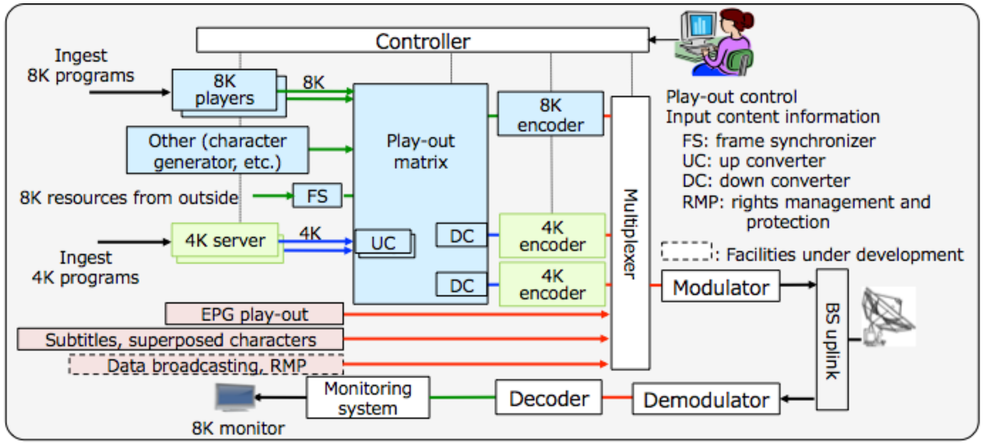
System configuration
HEVC codec
MMT multiplexer
Satellite transmission

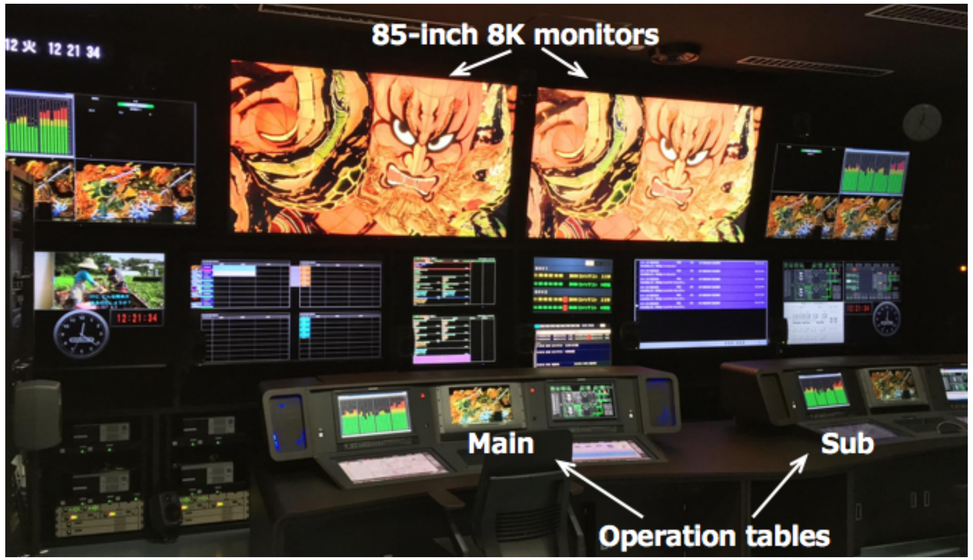
System configuration



Playout

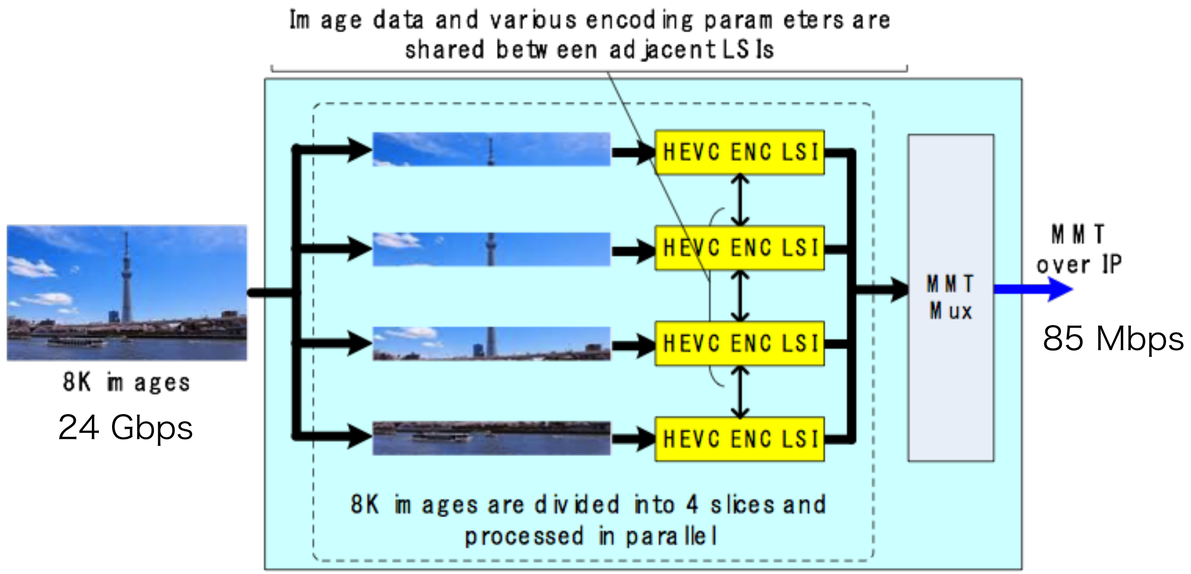
- Video: 8K x 1ch or 4K x 2ch
- Audio: 22.2ch, 5.1ch, and stereo
  Simultaneous deliver
- Video encode: HEVC/H.265
- Audio encode: AAC@LATM/LOAS
- Transport: MMT/TLV
- Time ref.: Network time protocol
- Program info.: MMT-SI





8K HEVC Encoder

- Input video/audio
  - 8K/4K: Opt. (ARIB STD-B58)
    8K (Dual green): 3G-SDI x 8
    4K: 3G-SDI x 4
  - 22.2 ch (32 ch max.)
- Encode video/audio
  - HEVC/H.265 Main10@Level6.1
    60M-200Mbps (8K) 15M-160Mbps(4K)
    HDR capable
  - MPEG4 AAC
- Output
  - MMT or MPEG-2 TS



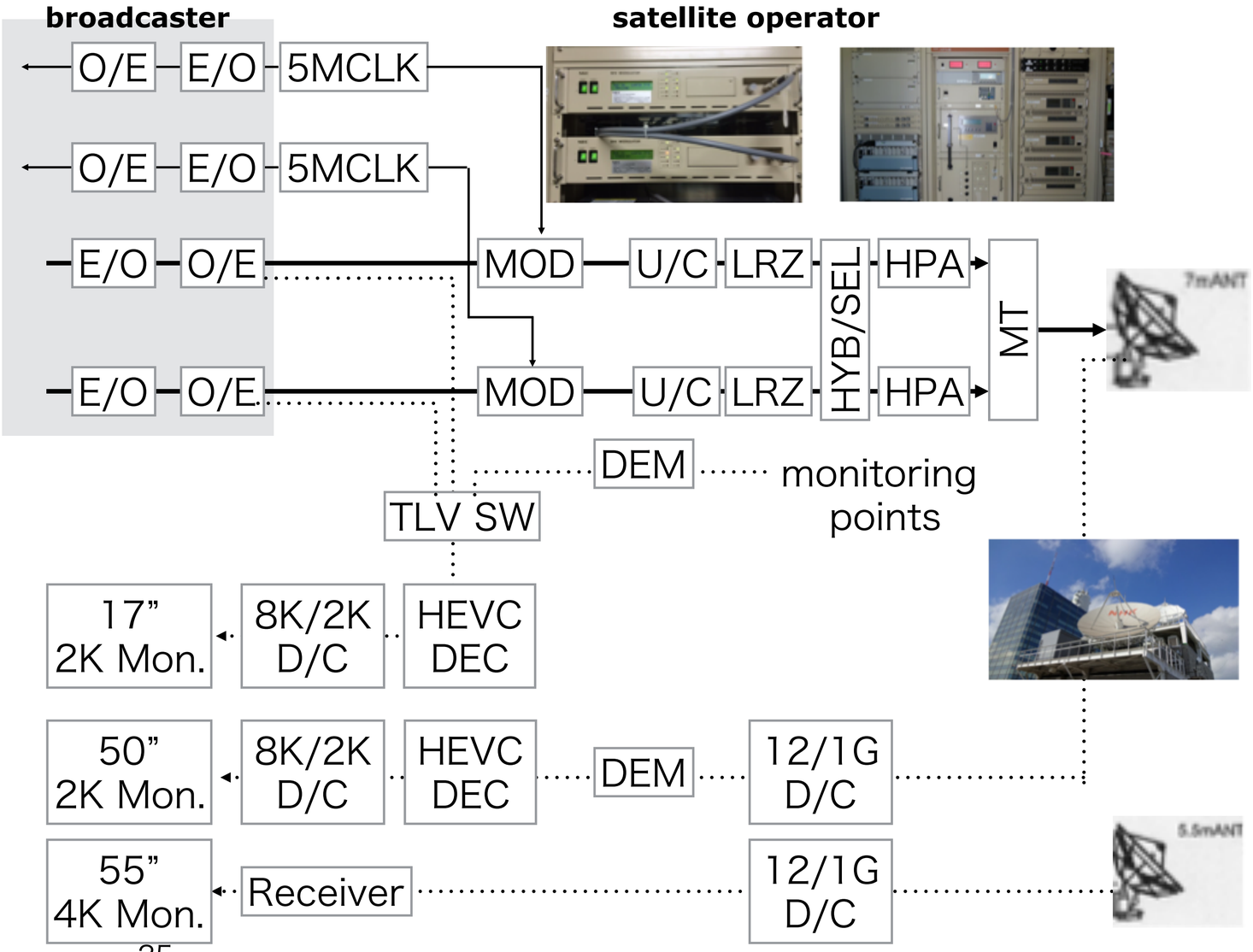
Multiplexer

- MMT Mux
  - Multiplex MMT packets
  - Video, audio
  - EPG, closed caption, etc.
- TLV Mux
  - TLV packet generation from MMT packet
  - TMCC

MMT Multiplexer

Satellite Transmission

- Up-link
  - ISDB-S3 modulator
  - Linearizer
    - compensate TWT non-linearity
- BSAT-3
  - BS 17ch (12.03436 GHz)
  - 100 % coverage in Japan
  - 45 cm receiving antenna



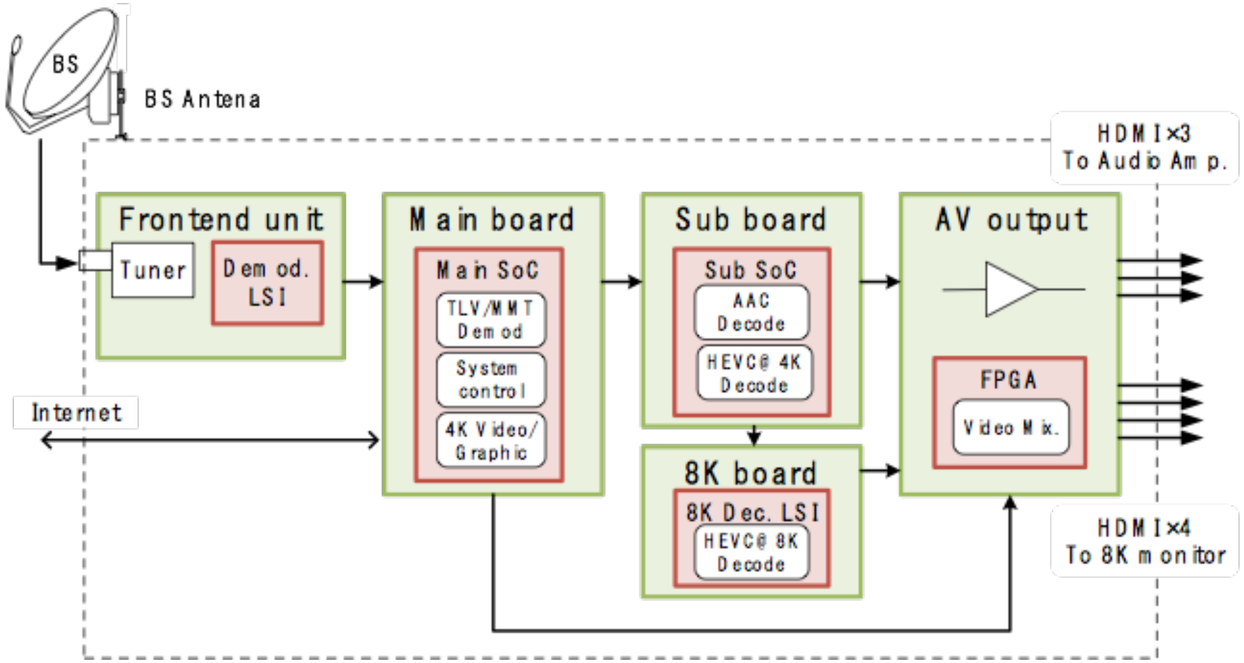
西田勇人 (2016). "4K・8K試験放送用アップリンク地球局." 放送技術(12).

Receiver

STB
8K HEVC decoder LSI
Display panel
Audio

STB

- Channel: BS17ch, ISDB-S3
- Colorimetry: Rec. BT.2020
- HDR: Rec. BT.2100 (HLG)
- Closed captioning: Yes
- Multimedia: HTML5 Browser
- Input: RF, LAN, 3 USB
- Output: 8K (HDMI2.0 x4)
  22.2ch (HDMI x 3)
- Size(mm^3): W435 x D617 x H170
- Weight(kg): Approx. 14
- Power consumption(W): 140



Mitani, K. (2016). 8K/4K UHDTV satellite broadcasting in Japan. EBU TECHNICAL ASSEMBLY 2016, Geneva.

8K HEVC Decoder LSI

- Video format: 7680 x 4320/60P
- Input: PCI Express Gen2
- Output: HDMI 2.0 x 4ch
- On-board memory: DDR3 4GB x 4
- Size (mm^2): 45 x 45

https://www.socionext.com/jp/pr/sn_pr20160323_01j.pdf

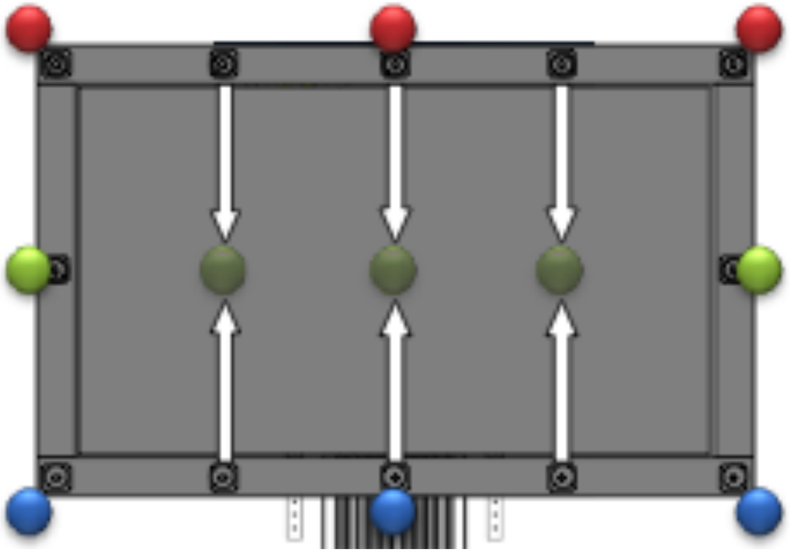
85” LCD panel

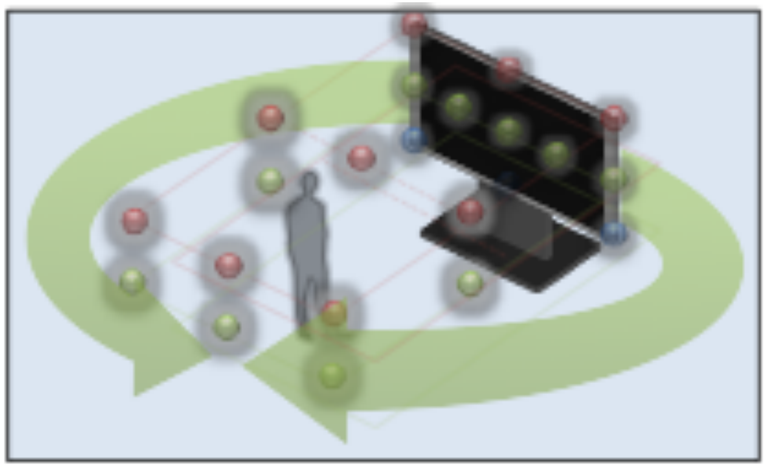
- Video: 7680 x 4320, 120Hz, 12bit
- Colorimetry: Rec.BT.2020
- Peak luminance: 1,000 nits
- Contrast ratio: 100,000:1 (local dimming)
- HDR:HLG, HDR conversion from SDR
- External input: 8K(HDMI 2.0 x 4), 4K

http://www.sharp.co.jp/business/8k-display/products/lv85001_feature.html

22.2 multi-channel audio reproduction

- Ideal speaker installation at home is not always possible.
- 22.2 ch reproduction with built-in loudspeakers
- Stereophonic method for front position channels
- Binaural signal processing for side and rear position channels





Oode, S., et al. (2014). 12-loudspeaker system for three-dimensional sound integrated with flat-panel display. 2014 NAB BEC, Las Vegas.

Standards/Guidelines for HDR

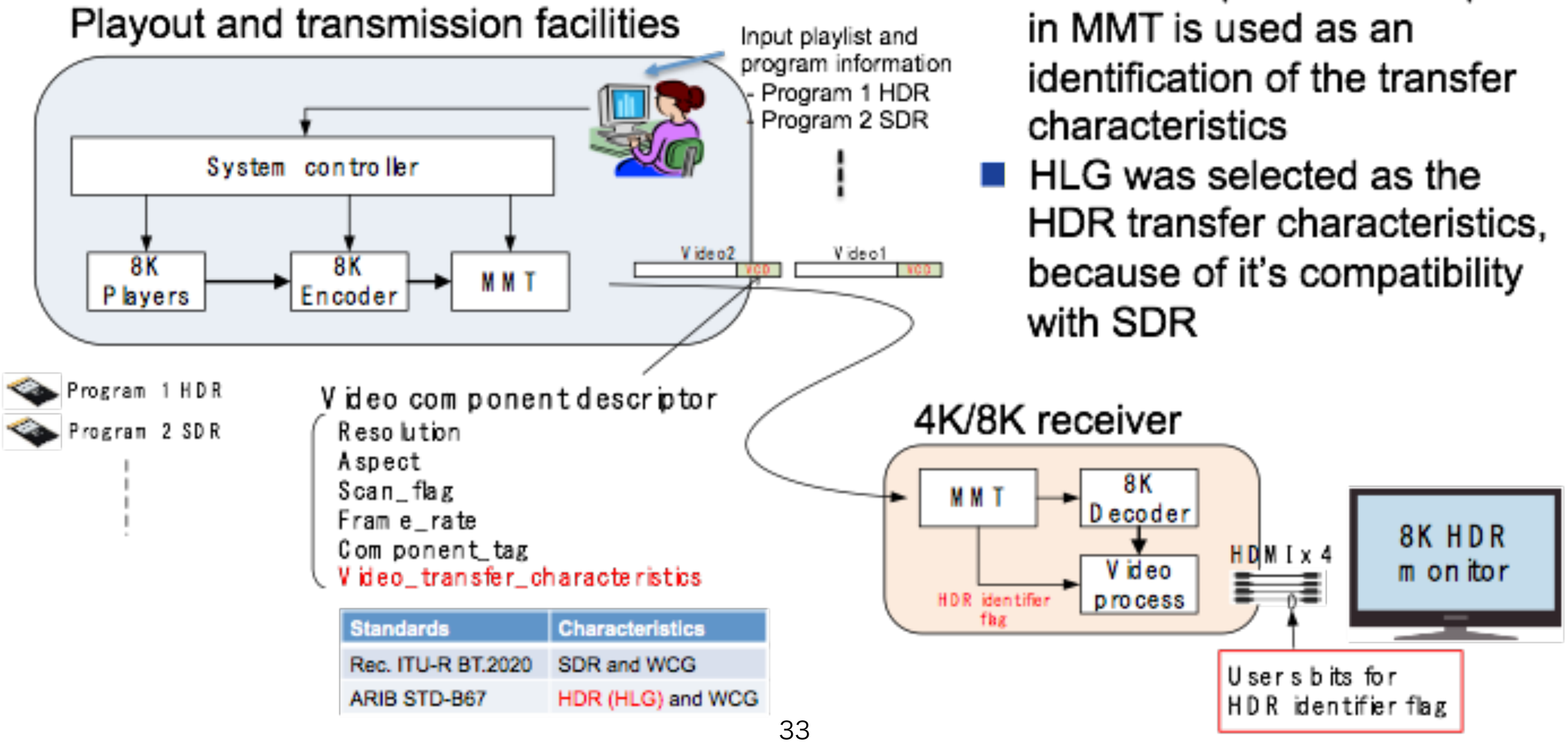
Requirements and Specifications
Operation

Requirements and Specifications

- Compatibility with existing SDR displays
  - A new service, but still a degree of compatibility is desirable.
  - It is recognized that HLG provides a good compatibility.
- Picture quality and bit rate increase
  - HEVC Main10 profile is used for high picture quality.
  - Objective test and experts' observation indicate a similar range of bit rate to SDR can provide good HDR reproduction.
- HDR/SDR mixed programming
  - An identifier in multiplexed stream as well as VUI in video elementary stream was specified.
  - Recommended practices for smooth mode switching were specified.

http://www.soumu.go.jp/main_content/000417995.pdf

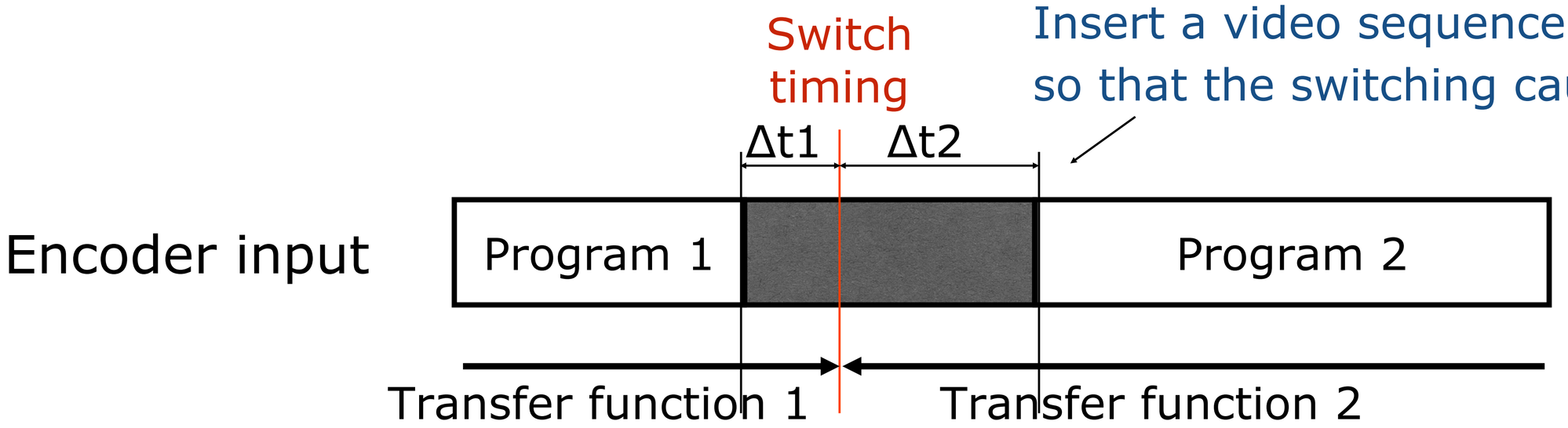
Operation



Standards	Characteristics
Rec. ITU-R BT.2020	SDR and WCG
ARIB STD-B67	HDR (HLG) and WCG

- Video component descriptor in MMT is used as an identification of the transfer characteristics
- HLG was selected as the HDR transfer characteristics, because of it's compatibility with SDR

Transfer functions switching



Insert a video sequence such as black so that the switching causes no trouble.

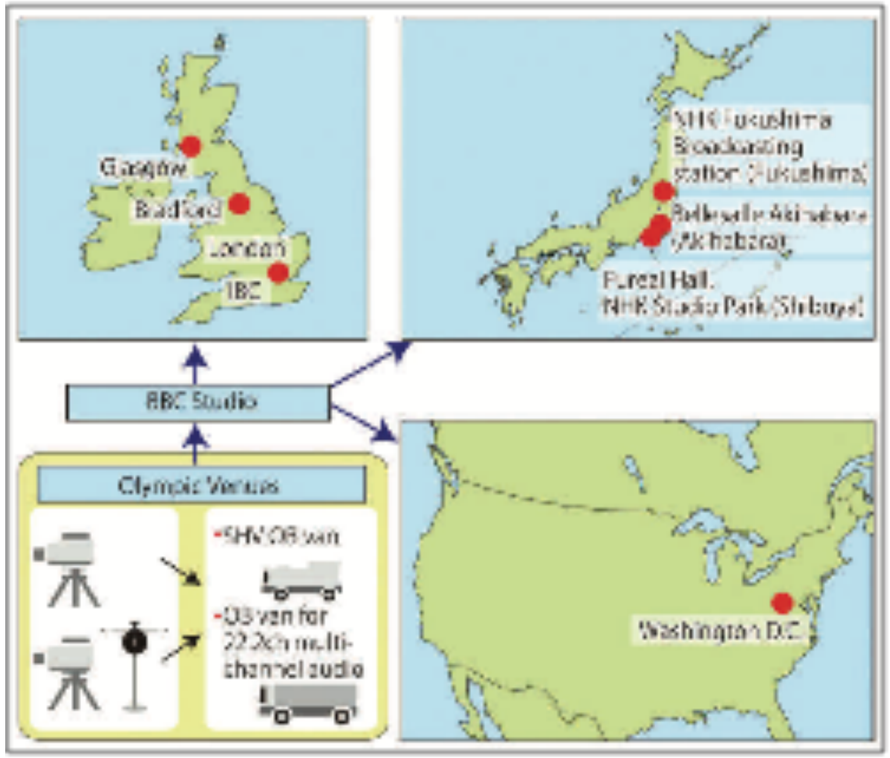
A display has to switch its transfer function during the interval.

ARIB STD-B32 ver. 3.9

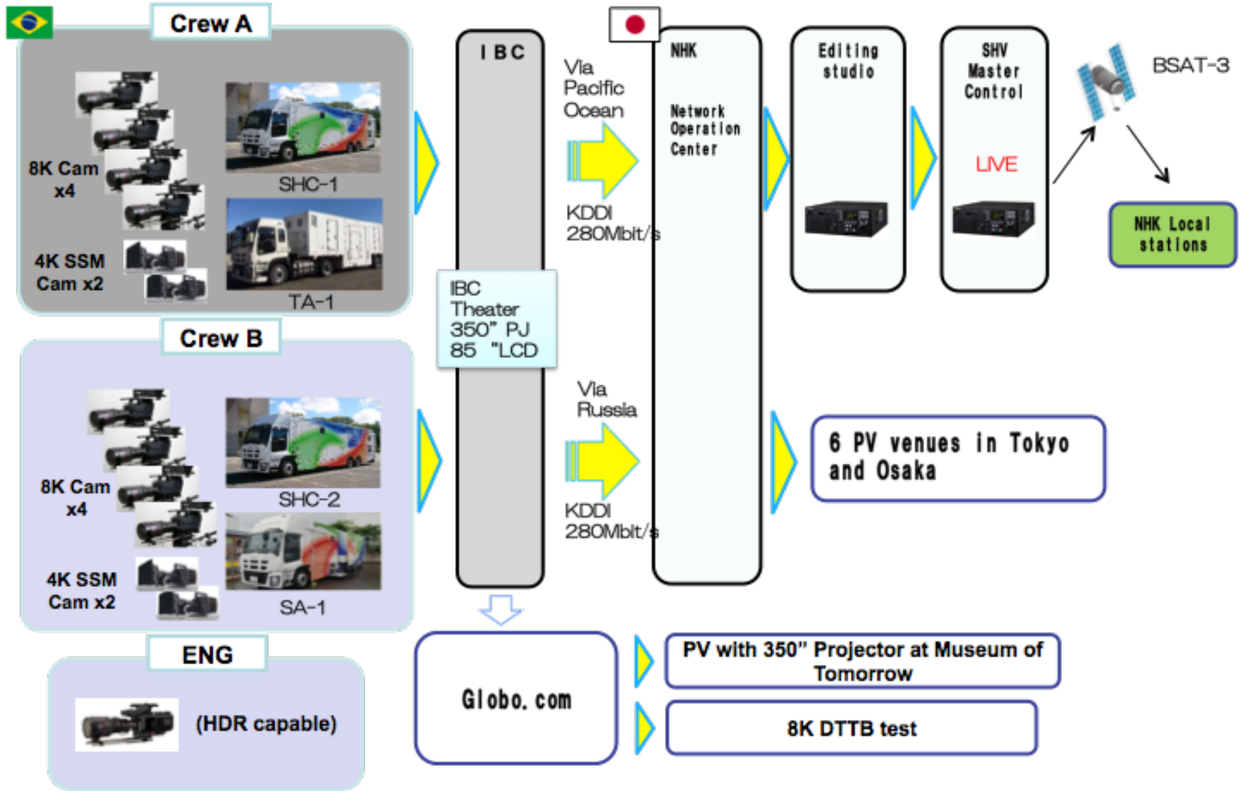
Future prospect

Progresses between London and Lio
Next step in the roadmap
New satellite channel

Progress between London 2012 and Rio 2016



Sugawara, M., et al. (2013). "Super Hi-Vision at the London 2012 Olympics." SMPTE Motion Imaging Journal **122**(January/February): 29-39.



東嘉和, et al. (2016). "リオデジャネイロ五輪における NHKのSK制作と試験放送." 放送技術 **2016**(11): 107-121.

London 2012

Rio de Janeiro 2016

Toward commercial broadcasting in 2018

- **BS Right**-handed circularly polarized wave <In use>

4K

- **BS Left**-handed circularly polarized wave <New>

4K

8K

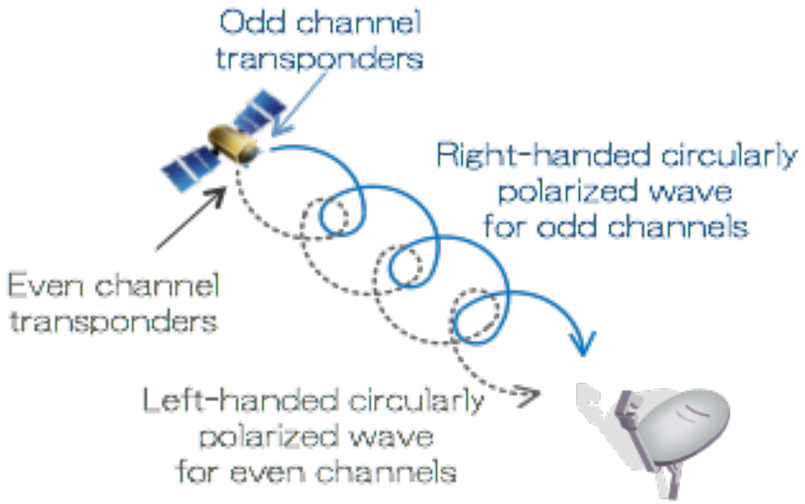
- **CS Left**-handed circularly polarized wave <New>

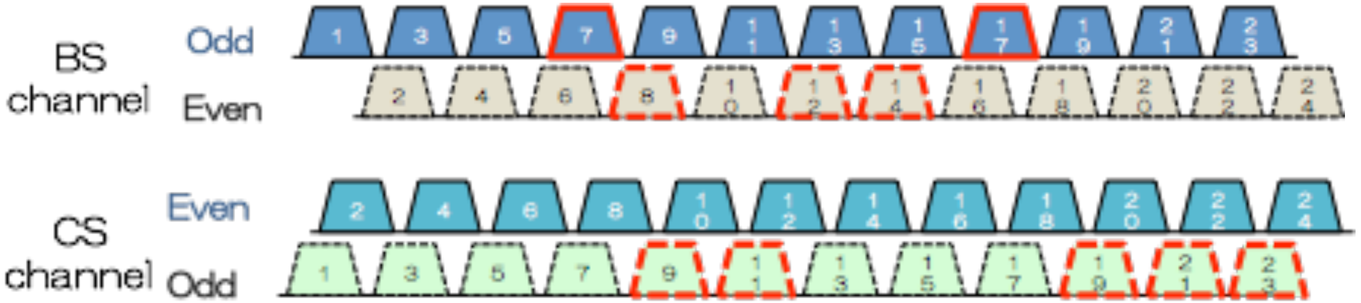
4K

http://www.soumu.go.jp/menu_news/s-news/01ryutsu11_02000082.html

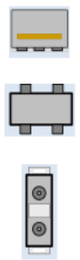
New satellite channels

RF





IF



1032.23M

2070.25M

2224.21M

3223.25.M

JEITA Label for 3224MHz capable equipment

Summary

- The World’s First 8K/4K “Regular” Broadcasting
- All parts of broadcast chain have been constructed.
- Many programs in various genre are being provided.
- Standards/Guidelines for practical HDR introduction
- Commercial launch is expected in 2018.

**Presentation materials: Courtesy of Ikegami, NHK, Sharp*

Thank you.