The World’s First 8K Broadcasting & 8K Production at Rio Olympics
-Production Infrastructure Development in Converged Environment-

Narichika Hamaguchi
NHK, Japan
4K/8K UHDTV is called Super Hi-Vision (SHV)
Viewing distance is 0.75 times of screen height.

100° Field of view.

High Resolution.
Wide Color Gamut

✓ Reproducing vivid colors

BT.709

BT.2020

Colorimetry specified in ITU-R Rec. BT.2020
High Frame-rate
✓ Better motion portrayal

60 Hz

120 Hz

* SHV broadcasting: 59.94p

High Dynamic Range
✓ Expansion of brightness range

SDR

HDR

* SHV broadcasting: Hybrid-Log Gamma
Advanced Sound System

22.2 multichannel sound system

- Upper layer speakers (9)
- Middle layer speakers (10)
- Lower layer speakers (3)
- Low frequency effect subwoofers (2)

Rec. ITU-R BS.2051
ROUNDPAM OF SHV BROADCASTING IN JAPAN

2011
8K public viewing

2012
8K public viewing

2013
Set up 4K/8K-testbed

2014
4K test broadcasting

2016
8K test broadcasting

August 1st, 2016 ~ 110°BS

2018
4K/8K full service for consumers

2020
4K/8K Broadcasting

4K broadcasting with Communication satellite
Started Mar 2015

4K/8K broadcasting Via broadcasting satellite 2018

2013
Completion of Analog switch-off

2016
4K/8K experimental service

2018
4K/8K Broadcasting via broadcasting satellite

2018
4K/8K Broadcasting with Communication satellite

2020
4K/8K Broadcasting

2K Terrestrial broadcasting

2003
ISDB-T

2011
2012
2013
2014
2016
ISDB-S3

2018
2020
TEST SATELLITE BROADCASTING STARTED 2016 AUG 1ST
85-inch 8K monitors

Main

Sub

Operation tables
PLAY-OUT & TRANSMISSION FACILITIES

- **Ingest 8K programs**
  - 8K players
  - Other (character generator, etc.)
  - 4K server

- **8K resources from outside**
  - FS

- **Ingest 4K programs**
  - EPG play-out
  - Subtitles, superposed characters
  - Data broadcasting, RMP

- **Play-out control**
  - Input content information
  - FS: frame synchronizer
  - UC: up converter
  - DC: down converter
  - RMP: rights management and protection

- **8K encoder**
  - Play-out matrix
  - UC
  - DC
  - 4K encoder

- **Multiplexer**
  - Facilities under development

- **Modulator**
  - BS uplink

- **Demodulator**

- **Decoder**

- **Monitoring system**

- **8K monitor**

- **BS uplink**

- **Data broadcasting, RMP**

- **4K encoder**

- **4K server**

- **4K**

- **8K**

- **Controller**

- **Input content information**

- **Facilities under development**
CHANNEL ASSIGNMENT OF SHV SATELLITE BROADCASTING

- Channel 17 is used for SHV test satellite broadcasting from August 2016.
- Even numbered channels/transponders will be available in 2018.

<table>
<thead>
<tr>
<th>BS channel</th>
<th>Odd</th>
<th>Even</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>12</td>
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<tr>
<td></td>
<td>13</td>
<td>14</td>
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<td>15</td>
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<td>19</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>
## SPECIFICATIONS OF TEST BROADCASTING

### Video/Audio/Multimedia coding parameters

<table>
<thead>
<tr>
<th>Items</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video format</td>
<td>4320/59.94p, 2160/59.94p</td>
</tr>
<tr>
<td>Colorimetry</td>
<td>ITU-R BT.2020</td>
</tr>
<tr>
<td>Video coding</td>
<td>H.265</td>
</tr>
<tr>
<td>Audio format</td>
<td>22.2 chs., 5.1chs. and Stereo</td>
</tr>
<tr>
<td>Audio coding</td>
<td>MPEG-4 AAC</td>
</tr>
<tr>
<td>Multimedia coding</td>
<td>HTML5, ARIB TTML</td>
</tr>
<tr>
<td>Multiplexing</td>
<td>MMT</td>
</tr>
</tbody>
</table>

### Transmission parameters

<table>
<thead>
<tr>
<th>Items</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency band</td>
<td>BS channel 17 (12.03436 GHz)</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>34.5 MHz</td>
</tr>
<tr>
<td>Modulation</td>
<td>16APSK</td>
</tr>
<tr>
<td>Symbol rate</td>
<td>33.7561 MBaud</td>
</tr>
<tr>
<td>Payload bit rate</td>
<td>Approx. 100 Mbit/s</td>
</tr>
</tbody>
</table>

* 8K x1 or 4K x2 services using one channel
SHV RECEIVER

**Specifications**

<table>
<thead>
<tr>
<th>Items</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receivable channel</td>
<td>BS channel 17 (8K &amp; 4K programs)</td>
</tr>
<tr>
<td>Color gamut</td>
<td>Rec. BT 2020</td>
</tr>
<tr>
<td>HDR</td>
<td>HLG (ARIB STD-B67)</td>
</tr>
<tr>
<td>Closed captioning</td>
<td>Yes</td>
</tr>
<tr>
<td>EPG</td>
<td>Yes</td>
</tr>
<tr>
<td>Multimedia</td>
<td>HTML5 Browser</td>
</tr>
</tbody>
</table>

**Input**

<table>
<thead>
<tr>
<th></th>
<th>RF</th>
<th>LAN</th>
<th>USB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Only for maintenance)</td>
</tr>
</tbody>
</table>

**Output**

<table>
<thead>
<tr>
<th></th>
<th>Video</th>
<th>Audio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8K (HDMI 2.0 x 4)</td>
<td>22.2 ch (HDMI x 3)</td>
</tr>
</tbody>
</table>

**Size**

- (W) 435 x (D) 617 x (H) 170 mm³

**Weight**

- Approx. 14 kg

**Power consumption**

- 140 (W)
### Specifications of LSI

<table>
<thead>
<tr>
<th>Items</th>
<th>Specifications</th>
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</thead>
<tbody>
<tr>
<td>Video format</td>
<td>7680 x 4320, 60P</td>
</tr>
<tr>
<td>Input</td>
<td>PCI Express Gen2</td>
</tr>
<tr>
<td>Output</td>
<td>HDMI 2.0 x 4ch</td>
</tr>
<tr>
<td>On-board memory</td>
<td>DDR3 4GB x 4</td>
</tr>
<tr>
<td>Size</td>
<td>45 mm x 45 mm</td>
</tr>
</tbody>
</table>
8K CAMERAS

Steady-Cam

Lightweight Steady-Cam

*Freefly (2kg)

Various Lenses

Cinema Cam

Laparoscope
8K DISPLAYS

8.3 inch (OLED)

9.6 inch

13.3 inch

17.3 inch (Flexible OLED)

27 inch (HDR)

30 inch

32 inch

55 inch

65 inch

85 inch (HDR)

98 inch QLED
8K PRODUCTION-TRUCKS

The world’s first OB-Vans of 8K productions
Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>SHC-1</th>
<th>SHC-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle size</td>
<td>Length: 11.9 m, height: 3.3 m</td>
<td></td>
</tr>
<tr>
<td>In-Vehicle Equipment</td>
<td>10 cameras, 4 record/playback units</td>
<td>4 slow-motion units</td>
</tr>
<tr>
<td>Video Mixer</td>
<td>16 inputs</td>
<td>20 inputs</td>
</tr>
<tr>
<td></td>
<td>1 video-synthesis function 3G-SDI Baseband Switcher</td>
<td>2 video-synthesis functions SDI over IP Switcher</td>
</tr>
</tbody>
</table>

Slide-out (Slow-motion production, etc.)
Specifications

- Mixing room for 3D sound mixing
  Vehicle length: 11.5 m
  Vehicle height: 3.49 m
- Multi-format production
  22.2ch, 5.1ch, 2ch
RIO OLYMPICS 8K PRODUCTIONS

Crew-A
- Opening Ceremony, Swimming, Basketball
- 8K Cam x4
- 4K Slow-Mo Cam x2

Crew-B
- Judo, Athletics, Soccer, Closing Ceremony
- 8K Cam x4
- 4K Slow-Mo Cam x2

IBC PV theatre 350 inch PJ
85 inch LCD

Via Pacific Route
KDDI 280Mbit/s

NHK Tokyo Network Center
Recording, Editing

Via Russia
KDDI 280Mbit/s

RX Studio
SHV TOC

LIVE

BSAT-3

NHK Branch Stations

SHC-1

TA-1

SHC-2

SA-1

Globo.com

5 PV locations in Tokyo and Osaka

350 inch PJ at Museu do Amanhã
Terrestrial Transmission Trial

※HDR Production in Opening Ceremony

ENG Crew

Globo.com

※HDR Production in Opening Ceremony

Globo.com

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8K PRODUCTION - RIO OLYMPIC GAMES -
INTERNATIONAL LINES

- Pacific route (x2) and Russia route (x2) = 4 routes
- 140Mbit/s stream x2 = 280Mbit/s using H.264 compression
PUBLIC VIEWING (NHK JAPAN)

NHK Fureai Hall 480inch Projector

NHK Kyoto  220inch
PUBLIC VIEWING (BRAZIL)

IBC 350inch Theater

TOKYO2020 JAPAN HOUSE
85inch LCD
4K DISTRIBUTION FOR HYBRIDCAST/VOD VIA BROADBAND

*(A) & (B): Commercially available 4K HybridCast TVs, 4K IPTVs, and 4K VOD supported TVs
CONCLUSIONS

- Infrastructure development for SHV broadcasting.
  - 8K cameras, 8K recorders, 8K displays, OB-trucks
  - Play-out facilities, Satellite transmission, and Receivers
  - From camera to receiver, all broadcasting chains are 8K ready

- Future plan toward Tokyo 2020.
  - Full service of SHV broadcasting will launch in 2018.
  - 8K TV set will be available for consumers.
  - Next generation terrestrial broadcasting (test).
  - 8K distribution via ultra-high speed broadband & 5G.
8K TRANSMISSION

Terrestrial
- Ultra-multilevel OFDM
- Dual Polarized MIMO

Test was conducted in Japan and Brazil

CATV

Cable TV Operator (Head-end)
Mod. 256 QAM
Divider and multiplexer
Demod. 256 QAM
Combination
Subscriber

Cable TV transmission path

Frequency
256 QAM 64 QAM

Combination

Broadband

MMT/IP transmitter

10G E-PON

MMT receiver

11-channel 8K multicast delivery over 10G broadband

11x120 Mbps = 1.3Gbps

5G Mobile

Experiments by NTT Docomo and Nokia