Status of UHDTV broadcasting in Republic of Korea

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Backgrounds in Rep. of Korea

- Successful termination of terrestrial analog broadcasting in 2012
  - ATSC, Video: 1920x1080i MPEG-2, Audio: Max 5.1ch AC-3

- Requesting a post-HDTV broadcasting service in Terrestrial
  - 2010 ~ 2011: 3DTV
  - 2012 ~: UHDTV

- UHDTV, not only by Satellite TV but also Terrestrial Broadcasting

- Problems of Terrestrial UHDTV broadcasting
  - Huge amount of video data
  - Narrow and limited frequency bandwidth
Backgrounds

❖ **Need** new technology and equipment for making 4K video and terrestrial broadcasting
  - 4K camera .... → **2009** ~, RED, Sony, Canon ....
  - High speed & mass storage or media for 4K video recording → SSD or memory based storage ..... 
  - Transmission → DVB-T2, **2008**
  - Video Codec → HEVC, **2013**, JCT-VC
Terrestrial UHDTV broadcasting

- In 2012, 4 major terrestrial broadcasters in Rep. of Korea participate in the project UHDTV
  - Supported by the regulatory body of MSIP (Ministry of Sciences, ICT and Future Planning) and KCC (Korea Communications Commission)
General Information

- **UHDTV Trial License : Phase I**
  - Sept. 1 ~ Dec. 31 2012
  - Just 4 months
  - Licensed by KCC

- **Main Feature of UHDTV Trial**
  - World’s First Terrestrial 4K 30P Trial On-Air
  - Tx Scheme
    - DVB-T2 256QAM, 6MHz Bandwidth
    - Tx Power : 100W
    - Frequency : 785MHz
  - Codec System
    - HEVC Encoding / MPEG-2 TS
    - 4K 30P Content Production
    - Real Time Decoding & 4K 30P Display

- **UHDTV Trial License : Phase II**
  - May. 10 ~ Oct. 15 2013
  - About 5 months
  - Licensed by MSIP

- **Main Feature of UHDTV Trial**
  - 4K 60P Trial On-Air
  - Tx Scheme
    - Same System and Tx Power
    - Various System Parameters
  - Codec System
    - HEVC Encoding / MPEG-2 TS
    - 4K 60P Content Production
    - Real Time Decoding & 4K 60P Display
System Configuration – Phase 1

Sept. 1 ~ Dec. 31 2012
Encoding – Phase 1

- Video Codec : HEVC (HM v6.0)
- Video format : 4K(3840x2160), 4:2:0, 8bits, 30fps
- Encoder type : non real-time S/W encoder
  (Usually, it takes over a day to encode a video of one minute long)

- Encoding settings for 4K-UHD experimental broadcasting
  - Profile : main profile
  - Maximum coding unit size : 64x64
  - Intra Period : 32
  - GOP size : 8
  - Bitrate : 30Mbps approx.
  - Rate control : not applied
  - Quantization parameter : manually adjusted
    (28, 30, 32, 34...)

Video : HEVC ES
Audio : AC3
Mux
HEVC TS (Transport Stream)
Transmission – Phase 1

<table>
<thead>
<tr>
<th>DVB-T2</th>
<th>Parameter</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>6MHz</td>
<td></td>
</tr>
<tr>
<td>Channel Number</td>
<td>UHF 66ch (Fc 785Mhz)</td>
<td></td>
</tr>
<tr>
<td>Transmission Power</td>
<td>100 W</td>
<td></td>
</tr>
<tr>
<td>Transmission Distance</td>
<td>10.61 km (Line of Sight)</td>
<td>Transmitting station &lt;--&gt; Receiving point</td>
</tr>
<tr>
<td>Valid Data-rate (maximum)</td>
<td>36.56 Mbps</td>
<td></td>
</tr>
</tbody>
</table>

**DVB-T2 Parameter**

1. FFT Size 32K
2. Pilot Pattern PP7
3. Symbol Mapping 256-QAM
4. Constellation Rotation ON
5. FEC (Forward Error Correction) LDPC 64,800 blocks
6. Time Interleaver Single Type
7. Time Interleaver Length 3
8. Guard Interval 1/128
9. Code Rate 5/6
Transmission – Phase 1

- **Gwanak Transmission Site/Tx Systems**

  - Elevation of the Site: 660m
  - Located in the south of Seoul
  - Key digital TV & DMB site for Seoul Area

  **TX Tower**

  - DVB-T2 / RF Power 100W / 4 Dipole
  - Horizontal Polarization
  - 3 panels 6.03dBi (60/150/330°)

  **100W DVB-T2 (Rohde & Schwarz)**

  - DVB-T2 256QAM
  - LDPC 5/6 36.5Mbps
Reception and Viewing – Phase 1

Real-time HEVC Decoder (Government-run R&D project)

HDMI 1.4a x 1 (30P)
DVI x 2 (30p, 60P)
HD-SDI x 4 (30p, 60P)
In December 2012, we were ongoing the field test for 4K UHDTV transmission by DVB-T2 5Km away from KBS Gwanak Tx Site.

<table>
<thead>
<tr>
<th>Point</th>
<th>Reception Level[dBm]</th>
<th>MER[dB]</th>
<th>TS Error</th>
<th>Reception</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-50.8</td>
<td>32.7</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>-59</td>
<td>29.3</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>-43.7</td>
<td>35</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>4</td>
<td>-42.4</td>
<td>37.6</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>-54.7</td>
<td>30.9</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>6</td>
<td>-74.8</td>
<td>N/A</td>
<td>N/A</td>
<td>Bad</td>
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<tr>
<td>7</td>
<td>-57.1</td>
<td>29.8</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>8</td>
<td>-63.8</td>
<td>25</td>
<td>N/A</td>
<td>Bad</td>
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<tr>
<td>9</td>
<td>-84.9</td>
<td>N/A</td>
<td>N/A</td>
<td>Bad</td>
</tr>
<tr>
<td>10</td>
<td>-54.6</td>
<td>28.6</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>11</td>
<td>-60.7</td>
<td>N/A</td>
<td></td>
<td>Bad</td>
</tr>
<tr>
<td>12</td>
<td>-57.9</td>
<td>27.6</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>13</td>
<td>-58.5</td>
<td>29</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>14</td>
<td>-60.4</td>
<td>27.4</td>
<td>No Error</td>
<td>Good</td>
</tr>
<tr>
<td>15</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Bad</td>
</tr>
</tbody>
</table>
4K contents - KBS

- 2010. Drama “The slave hunters”
  24 episodes, 4K 24p by Red One
- 2011. Drama “The Princess’ Man”
  9 of 24 episodes, 4K 24p by Red Epic
- 2012. Drama “Gaksital”
  4 of 28 episodes, 4K 24p by Red Epic
- 2012. Two short documentary,
  4K 30p by Sony F65
- 2012~2013. Long term documentary “Colors for Desires”
  4K 60p by Sony F65
- 2013~. Long term documentary “Food Odyssey”
  4K 60p by Sony F55, Red Epic and Canon C500
System Configuration – Phase 2

May. 10 ~ Oct. 15 2013
Transmission - Phase 2

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- Test with variable DVB-T2 parameters for 4K 60p
- Wide Area Field test
Field Test – Phase 2

- Field Test and Measurement is ongoing in October 2013
  - Testing for 4K 60p with both 256QAM and 64QAM
  - Testing around wide area (10 to 52Km) away from the Tx site
Encoding – Phase 2

- Video Codec: HEVC (HM v10.0)
- Video format: 4K (3840x2160), 4:2:0, 8 bits, 60fps
- Encoder type: non real-time S/W encoder
  (Usually, it takes over a day to encode a video of 10 minute long)

Encoder set-up for 4K-UHD experimental broadcasting

- Profile: main profile
- Maximum coding unit size: 64x64
- IntraPeriod: 64
- GOPsize: 16
- Bitrate: 25Mbps approx.
- Rate control

Video: HEVC
Audio: AC3
HEVC TS (Transport Stream)
30p vs 60p

- Test for Bit Rate increase

- Increase 15~40% Bit rate over HD resolution on condition of same QP (video quality)

- Average 30% increase
Field Trial, now on Going - Terrestrial

- Experimental 4K UHDTV Broadcasting Phase III in 2014
  - Upgraded video: 4K 60p 8bits to 4K 60p 10bits
  - Upgraded Power: 5KW
  - SFN test
  - Period: March 24 ~ Dec. 31 2014

- Establishing standard of organization for terrestrial 4K UHDTV

- Big Events related to 4K and 8K UHDTV
  - 2014: Asian Athletic Games in Incheon, Rep. of Korea
    - Live 4K
  - 2015: Willing to start 4K UHDTV
    - Start time is in talks with the government
  - 2018: Pyeongchang Winter Olympic Games, Rep. of Korea
    - 8K UHDTV
4K UHDTV plan – Satellite and Cable

❖ Satellite (Ka and Ku band)
  ▪ 2013 : Established national standard for satellite broadcasting
  ▪ 2014 : Experimental and Test broadcasting
  ▪ 2015 : Start broadcasting

❖ Cable
  ▪ 2013 : Established national standard for cable broadcasting
  ▪ 2014 : Test broadcasting with set-top box built in UHDTV
  ▪ 2015 : Start broadcasting

- 4K-UHD video transmission experiment through Ka-band Chollian satellite
- H.264/AVC S/W NRT Encoding and RT Decoding for 4K-UHD source

### AV format
- 3840X2160, 30p, YUV4:2:0, 8bits / 5.1channel

### AV Coding
- H.264/AVC, MPEG-4 AAC

### Transmission
- DVB-S2, 8PSK ¾

### Bitrate
- 40Mbps/26MHz
4K-UHDTV trial broadcasting - Cable

- Cable based 4K-UHDTV trial broadcasting by ETRI - CJ HelloVision (Jan. 2013~)
  - Transmission of max. 70Mbps using Broadcast Channel Bonding over legacy digital cable broadcasting system

**AV format**

<table>
<thead>
<tr>
<th>Method</th>
<th>AV Coding</th>
<th>Transmission</th>
<th>Bitrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H.264/AVC, AC-3</td>
<td>ITU-T J.83 Annex B 256QAM with 2 channels bonding</td>
<td>70Mbps</td>
</tr>
<tr>
<td>2</td>
<td>HEVC, AC-3</td>
<td>ITU-T J.83 Annex B 256QAM with a channel</td>
<td>40Mbps</td>
</tr>
</tbody>
</table>
Conclusion

- Rep. of Korea has a very concrete plan to open UHDTV era for terrestrial, cable and satellite TV
  - Start time of terrestrial 4K UHDTV is in talks with the government

- We found a possibility of 4K UHDTV broadcasting using terrestrial DTV channels thanks to DVB-T2 system and HEVC

- Need more test and trials for 4K video encoding with HEVC

- For immersive UHDTV viewing
Thank You.