Digital Satellite Broadcasting and HDTV Services in Japan

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- Present situation of satellite broadcasting in Japan
- ISDB-S transmission system
  - features
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History of Satellite Broadcasting in Japan


Jun. 1989: NHK started regular service (NTSC) and experimental HDTV broadcasting using BS-2b.

Apr. 1991: BS-3 was in use. JSB started pay TV service.

Mar. 1996: Number of households that receive satellite broadcasting exceeded 10 million.

Aug. 1997: BS-3 was replaced by BS4-1.

Mar. 2000: Number of households that receive satellite broadcasting reached 14 million.

Outline Scenario for Digital Satellite Broadcasting

**ANALOG**
- **BS3**
  - NHK-1
  - NHK-2
  - JSB
  - MUSE
- **BS4-I**
  - FM - NTSC
- **BS5**
  - MUSE - HDTV

**DIGITAL**
- **BS4-II**
  - Simulcast channel
  - Digital HDTV/SDTV
  - Digital HDTV/SDTV
  - Digital HDTV/SDTV

Timeline:
- 1991
- 1997
- 2000
- 2007
- Year
Features of ISDB-S

- Large transmission capacity
  - two HDTV programs in one satellite channel
- Hierarchical modulation
  - minimum service available during heavy rain
- Operational flexibility
  - mixed transmission of HDTV and SDTV
  - independence between broadcasters who share one transponder
- Extensibility
  - EPG, data broadcasting, downloading, etc.
## Summary of the system characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modulation scheme</strong></td>
<td>TC8PSK/QPSK/BPSK</td>
</tr>
<tr>
<td><strong>Raised cosine roll-off factor</strong></td>
<td>0.35 ( \text{square root} )</td>
</tr>
<tr>
<td><strong>Transmission symbol rate</strong></td>
<td>28.86 Mbaud</td>
</tr>
<tr>
<td><strong>Video coding</strong></td>
<td>MPEG-2</td>
</tr>
<tr>
<td></td>
<td>MP@HL for 1080i</td>
</tr>
<tr>
<td></td>
<td>MP@ML for 480i</td>
</tr>
<tr>
<td></td>
<td>MP@H14 for 480p</td>
</tr>
<tr>
<td><strong>Audio coding</strong></td>
<td>MPEG-2 AAC</td>
</tr>
<tr>
<td><strong>FEC (Outer code)</strong></td>
<td>Reed-Solomon</td>
</tr>
<tr>
<td></td>
<td>(204,188)</td>
</tr>
<tr>
<td><strong>FEC (Inner code)</strong></td>
<td>Convolutional</td>
</tr>
<tr>
<td></td>
<td>(constraint length ( k=7 ))</td>
</tr>
<tr>
<td><strong>Inner code ratio</strong></td>
<td>1/2 for BPSK</td>
</tr>
<tr>
<td></td>
<td>1/2, 2/3, 3/4, 5/6, 7/8</td>
</tr>
<tr>
<td></td>
<td>for QPSK</td>
</tr>
<tr>
<td></td>
<td>2/3 for TC8PSK</td>
</tr>
<tr>
<td><strong>Transport Layer</strong></td>
<td>MPEG-2 systems</td>
</tr>
<tr>
<td><strong>Packet size</strong></td>
<td>188 bytes</td>
</tr>
</tbody>
</table>

**RF Bandwidth**: 34.5 MHz

**Payload Bit Rate**: 52 Mbps (max.)
Block Diagram of Channel Coding

**Main signal**

- MPEG-TS
  - #1
  - #2
  - ...
  - RS(204, 188)

- TMCC
  - TMCC encoding
  - Outer coding
  - RS(64, 48)

- Burst signal
  - Auxiliary Information
  - Additional encoding & channel coding
  - Energy dispersal

**Frames**

- Outer coding
- Frame structure
- Energy dispersal
- Interleave

**Coding**

- TDM
- Inner coding
- Modulation

**Control Data**

- #1
- #2
- ...

**Channel**

- Convolutional
Frame Structure and Transmission Signal

**Input TSs**

- 188 bytes
- MPEG Packet #A
- MPEG Packet #B
- MPEG Packet #C

**Frame structure**

- 204 bytes
- service A (high layer)
- service B (high layer)
- service C (high layer)
- parity

**Transmission signal**

- 1 super frame = 8 frames
- 1 frame = 48 slots
- frame #1
- frame #8
- TMCC slot #1 slot #1 slot #1 slot #1 slot #48
- TMCC slot #1 slot #1 slot #1 slot #1 slot #2 slot #48
Transmission and Multiplexing Configuration Control (TMCC)

TMCC carries:
- frame synchronization
- modulation scheme and coding rate applied to each slot
- TS identification for each slot
- emergency alert signal
- information about site-diversity operation, etc.

TMCC is modulated with BPSK and coded with RS(64,48)
Service Availability of 12GHz Satellite Broadcasting

Location = Tokyo
Antenna = 45 cm

- BPSK (r=1/2)
- QPSK (r=1/2)
- NTSC audio collapse
- TC8PSK

CNR (dB) vs. Service Availability (% of hours in worst month)
Cumulative Shut-off Hours in worst month (hours)
Example of Hierarchical Transmission

TC8PSK reception

QPSK/BPSK reception
Penetration of HDTV Receivers in Japan

Wide Screen TV with MUSE/NTSC Converter

HDTV Receiver

reached
934,000 at Aug. 1998
657,000 at Aug. 1998
Relationship between viewing distance and required number of scanning lines

Change of popular size of TV monitors in Japan

- Popular size has become larger
- Viewing distance remains unchanged (about 2m)
- HDTV is suitable for the digital age
Subjective Assessment of HDTV Picture Quality

Test Sequence (coded by MP@HL)

<table>
<thead>
<tr>
<th>Quality Degradation (DSCQS%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Original</td>
</tr>
</tbody>
</table>

Graph depicting subjective assessment of HDTV picture quality with test sequences coded by MP@HL.
Conclusions

- ISDB by satellite starts in December 2000

- The ISDB-S system
  - large transmission capacity of 52 Mbps/ch
    - two HDTV programs can be transmitted
  - robust transmission against heavy rain
    - multiple modulation schemes and hierarchical transmission
  - high operational flexibility
    - independence between broadcasters who share one transponder

- HDTV services in Japan
  - ISDB-S is expected to play a central roll on digital HDTV