Technical Features of ISDB-T

28th-29th August, 2006
In Caracas
DiBEG JAPAN
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Contents

• What is ISDB-T?
• Comparison of 3 DTTB systems
• Structure of ISDB-T Standard
• Technical details of ISDB-T
• Commonality of ISDB-Tsb (note)

(note) Digital Terrestrial Sound Broadcasting of ISDB
1. What is ISDB-T?

ISDB-T is • • •

• ISDB-T system was developed by the Association of Radio Industries and Businesses (ARIB) in Japan.
• ISDB (Integrated Digital Services Digital Broadcasting) is a new type of digital broadcasting intended to provide audio, video, and multimedia services. T is Terrestrial.
• ISDB-T is one of ISDB family.
• ISDB-T uses a modulation method referred to as Band Segmented Transmission (BST) OFDM.
At first, the requirement of digital broadcasting should be established. The requirements described above are for digitalization in Japan.

### Requirements for Digitalization

- Multimedia-service
- High-Quality TV/ Multi-Channels
- Flexible/Versatile
- Effective frequency utilization
- Mobile and handheld service (ground wave)
- Commonality of receiver

### Requirements for Digitalization → Solutions

- **High-Quality, Multi-Channels**
  - HDTV 1CH or SDTV 3CH within 6MHz band.
  - Robustness against multi-path

- **Multimedia-Service**
  - Integrated Service (Video/Audio/Data)
  - High quality Data Service
  - Bi-directional Service

- **Flexible/Versatile**
  - Single Frequency Network (SFN)

- **Efficient Spectrum utilization**
  - Robustness against mobile/portable reception
  - Both fixed/mobile service within same band → Layer Transmission Technology

- **Mobile and handheld service (ground wave)**
  - Commonality for BS/Cable/Terrestrial Broadcasting.
Features of ISDB-T

Technological Specification
- OFDM
- Segment Structure
- Time Interleaving
- TMCC

Japanese Requirements for DTTB
- Robustness, SFN
- Extensible, Partial Reception
- Mobile Reception, Indoor Reception
- Flexible, Versatile

What is Band Segmented OFDM with time interleave?

(Example; 1seg + 12 seg)

Layer A (LDTV, Audio, Data)

Layer B (HDTV or 3 SDTV with Data)

Handheld reception (One seg. Service)
Fixed reception, Mobile reception (HDTV, etc)

- Segmented OFDM; Possible to support fixed/mobile/handheld reception service
- Time interleave; reduce impulse noise and reduce the degradation caused by fading (tested in Brazil by Mackenzie and TV GLOBO)
2. Comparison of 3 DTTB Systems

- Comparison of 3 DTTV systems
- Results of comparison test in Brazil
- Summary of comparison
## Broadcasting Services

<table>
<thead>
<tr>
<th>Item</th>
<th>ATSC</th>
<th>DVB-T</th>
<th>ISDB-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDTV/ SDTV Fixed reception</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Data broadcasting</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>SFN</td>
<td>×</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>HDTV Mobile reception</td>
<td>×</td>
<td>×</td>
<td>☐</td>
</tr>
<tr>
<td>(SDTV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portable reception with cellular phone</td>
<td>×</td>
<td>△</td>
<td>☐</td>
</tr>
<tr>
<td>Internet access</td>
<td>×</td>
<td>△</td>
<td>☐</td>
</tr>
</tbody>
</table>

## Technical Detail of DTTV Systems - 1

<table>
<thead>
<tr>
<th>System</th>
<th>ATSC</th>
<th>DVB-T</th>
<th>ISDB-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video coding</td>
<td>MPEG-2 Video(ISO/IEC 13818-2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio coding</td>
<td>Dolby AC-3</td>
<td>MPEG-2 BC</td>
<td>MPEG-2 AAC</td>
</tr>
<tr>
<td>Data broadcasting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation engine</td>
<td>Dase-1</td>
<td>(DVB HTML)</td>
<td>BML (XHTML), ECMAScript</td>
</tr>
<tr>
<td>Execution engine</td>
<td>ACAP</td>
<td>DVB MHP</td>
<td>ARIB B 23</td>
</tr>
<tr>
<td>Multiplex</td>
<td>MPEG-2 Systems (ISO/IEC 13818-1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional access</td>
<td>DES / NRSS</td>
<td>CSS / DVB CA</td>
<td>Multi 2 / ARIB B 25</td>
</tr>
<tr>
<td>Error correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer</td>
<td>(207,187) Reed-Solomon code</td>
<td>(204,188) Reed-Solomon code</td>
<td></td>
</tr>
<tr>
<td>Inner</td>
<td>2/3Trellis Code</td>
<td>Conv.code(1/2-7/8)</td>
<td></td>
</tr>
</tbody>
</table>
### Technical Details of DTTV Systems - 2

<table>
<thead>
<tr>
<th>System</th>
<th>ATSC</th>
<th>DVB-T</th>
<th>ISDB-T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modulation</strong></td>
<td>8VSB</td>
<td>COFDM (QPSK, 16QAM, 64QAM)</td>
<td>Segmented COFDM (QPSK, QPSK, 16QAM, 64QAM)</td>
</tr>
<tr>
<td><strong>Interleaving</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Bit/Symbol time</strong></td>
<td>-</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Excess Bandwidth/Guard Interval</strong></td>
<td>11.5%</td>
<td>1/4, 1/8, 1/16, 1/32</td>
<td>1/2, 1/4, 1/8, 1/16, 1/32</td>
</tr>
<tr>
<td><strong>TMCC</strong></td>
<td>-</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Information bit rate</strong></td>
<td>19.39 Mbps</td>
<td>3.69 -23.5 Mbps</td>
<td>3.65 -23.2 Mbps</td>
</tr>
<tr>
<td><strong>Channel bandwidth</strong></td>
<td>6/7/8 MHz</td>
<td>6/7/8 MHz</td>
<td>6/7/8 MHz</td>
</tr>
</tbody>
</table>

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### Effect of Time Interleaving

- As the experimental result, time interleaving improve required CN ratio about 7 dB in mobile environment on 16QAM.
- Diversity system improve about 7dB on 16QAM.
- Time interleaving (time diversity) work independently from space diversity.
- That is the reason for advantage of ISDB-T in mobile environment.
- Time interleaving improve robustness against impulse noise interference that come from power line and motor cycle engine.
Results of Brazilian Tests

• Comparison testing of three DTTB systems
  – ATSC, DVB-T, ISDB-T

• Carried out from Aug. 1999 to April 2000

• Laboratories tests
  – AWGN, impulse noise, multipath interference

• Field tests
  – Coverage, indoor reception

Evaluation of C/N

• Interferer = White Noise

<table>
<thead>
<tr>
<th></th>
<th>ATSC</th>
<th>DVB-2K</th>
<th>DVB-8K</th>
<th>ISDB</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/N (dB)</td>
<td>14.6</td>
<td>19.0</td>
<td>16.9</td>
<td>18.6</td>
</tr>
</tbody>
</table>

• ATSC: 8VSB FEC=2/3 (19.39 Mbits)

• DVB & ISDB: Choice of parameters define C/N
  – DVB-2K: 64 QAM FEC=3/4 GI=1/16 2K (19.75 Mbits/s)
  – DVB-8K: 64 QAM FEC=2/3 GI=1/32 8K (18.09 Mbits/s)
  – ISDB: 64 QAM FEC=3/4 GI=1/16 4K 0.1s (19.33 Mbit/s)

(From the presentation of the Brazilian SET/ABERT study group at NAB2000)
Impulse Noise

- Better performance of the ISDB-T system, by introducing time interleaving

(From the presentation of the Brazilian SET/ABERT study group at NAB2000)

Static Multipath

Carrier to noise ratio as a function of carrier to echo ratio
Comparison at post-echo = 8us

(From the presentation of the Brazilian SET/ABERT study group at NAB2000)
Outdoor: Coverage

Success on Receiving - Cumulative Function
Criterion: Number of Errors < 5

Percentage of Sites

Distance (km)

(From the presentation of the Brazilian SET/ABERT study group at NAB2000)

Indoor Reception

Indoor Reception: Sites Where the Three Systems Were Tested in the Same Condition

Percentual de Recepção

Normal Reception  Reception + Blender On  Reception + People Walking Near Antenna

(From the presentation of the Brazilian SET/ABERT study group at NAB2000)
### Summary of Comparison (1/2)

Any improvement of digital receiver was not considered to make the table below.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>System conform to requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum bit rate under Gaussian noise environment</td>
<td>ATSC</td>
</tr>
<tr>
<td>Robustness against multi-path distortion</td>
<td>DVB-T, ISDB-T</td>
</tr>
<tr>
<td>Robustness against impulse noise</td>
<td>ISDB-T</td>
</tr>
<tr>
<td>Wide area single frequency network (SFN) operation</td>
<td>DVB-T, ISDB-T</td>
</tr>
</tbody>
</table>

### Summary of Comparison (2/2)

Any improvement of digital receiver was not considered to make the table below.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>System conform to requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility and Portability</td>
<td>ISDB-T &gt;&gt; DVB-T</td>
</tr>
<tr>
<td>Hierarchical transmission (Multiple modulation systems simultaneously in the same channel is possible)</td>
<td>ISDB-T &gt;&gt; DVB-T</td>
</tr>
<tr>
<td>System commonality with digital terrestrial sound broadcasting (One segment receiver is available)</td>
<td>ISDB-T</td>
</tr>
</tbody>
</table>
3. Structure of ISDB-T Standard

ARIB’s R&D and Standardization

- Technical Committee
- IMT-2000 Study Committee
- Electromagnetic Environment Committee
- R&D Group

Results of R&D → Petition to the Ministry for rule making

Draft ARIB Standard → Rule making by the Ministry

Standard Assembly → Demands for voluntary standards

ARIB Standard
Standardization for Broadcasters / Receivers

(Broadcasters)
- Service contents
- Segment utilization
- Transmission parameters
- SI
- CAS
- Network configuration
- Down load data
- Test stream

(Receivers)
- Signal Interface
- Tuner characteristic
- EPG
- Copy-right treatment
- Hardware size
- Interactive link
- Human interface

Toward Digital Broadcasting in Japan

CS (SDTV) Digital CS (SDTV) 1996
Digital Wide-band CS (HDTV, SDTV) 2002

BS (SDTV) Digital BS (HDTV, SDTV) 2000

Digital Terrestrial (Sound) Oct. 2003
Digital Satellite (Sound) Oct. 2004

2011
Features of ISDB-T

- **Technical Specification**: OFDM, Segment Structure, Time Interleaving, TMCC

- **Japanese Requirements for DTTB**: Robustness, SFN, Extensible, Partial Reception, Mobile Reception, Indoor Reception, Flexible, Versatile

Structure of Japan’s Digital Broadcasting system

- **Fixed/mobile service**
  - MPEG-2 Video coding
  - MPEG-AAC Audio coding
  - Data coding (note)
  - H.264 video coding

- **Multiplex (Based on MPEG-2 systems)**
  - Single carrier 8-PSK/PSK (satellite)
  - Single carrier 64QAM (cable)
  - Segmented OFDM QAM/DQPSK with time interleave (terrestrial)

- **Source coding**
  - (any of service are available)

- **Common interface (Transport Stream interface)**

- **Multiplex**
  - Common interface (Framed Transport Stream interface)

- **Transmission coding**

*(note) both BML and MHP are available, But in Japan now BML is only service in.*
Feature of Japan’s Digital Broadcasting system

(1) Flexibility of service: Interface between source coding and Multiplex is common interface (Transport Stream interface), so, any contents based on TS can be available.

(2) Flexibility of transmission media: Optimized to each transmission media.

(3) Terrestrial transmission system: For any reception type, such as fixed/mobile/handheld, adopt Segmented OFDM with time interleave (see next page)

What is Segmented OFDM with time interleave?

Layer A
(LDTV, Audio, Data)

Layer B
(HDTV or 3 SDTV with Data)

13 segments
(6 MHz bandwidth)

frequency

Handheld reception
(One seg. Service)

Fixed reception, Mobile reception (HDTV, etc)

- Segmented OFDM: Possible to support fixed/mobile/handheld reception service
- Time interleave: reduce impulse noise and reduce the degradation caused by fading (tested in Brazil by Mackenzie and TV GLOBO)

Digital Broadcasting Standard in Japan

Source coding

Video/Audio Coding (STD-B32)

Data Broadcasting (STD-B24)

Multi-Plex (STD-B32-B10)

Transmission coding

Satellite TV (STD-B20)

Terrestrial TV (STD-B31)

Terrestrial Audio (STD-B29)

Satellite Audio (STD-B41)

RMP (STD-B25)

Terrestrial Audio (STD-B30)

Satellite Audio (STD-B42)

Cable TV (JCL SPC-001)

Cable TV (JCTEA STD-004)

Receiver

Satellite/ Terrestrial TV (STD-B21)

Terrestrial Audio (STD-B30)

Source coding and MUX systems are common for each system

Transmission systems are different

Note: Cable transmission system standards are defined at another consortium
### Outline of ARIB Standards

**Source coding & Multi-plex**

<table>
<thead>
<tr>
<th>Name</th>
<th>Outline</th>
<th>note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video/Audio coding (STD-B32)</td>
<td>- Based on MPEG-2 video coding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Cover 1080i, 720p, 480p, 480i</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Based on MPEG AAC audio coding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Up to 5.1 Stereo audio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Based on MPEG systems multi-plex</td>
<td></td>
</tr>
<tr>
<td>Data Broadcasting (STD-B24)</td>
<td>- Data broadcasting description</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Data transmission format</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Small size Video coding (MPEG-4, H.264)</td>
<td></td>
</tr>
<tr>
<td>Program line-up information (STD-B10)</td>
<td>- PSI/SI description</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- EPG description</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Necessary for program selection</td>
<td></td>
</tr>
</tbody>
</table>

### Outlines of Standards (continued)

**Transmission coding**

<table>
<thead>
<tr>
<th>Name</th>
<th>Outline</th>
<th>note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite TV (STD-B20)</td>
<td>- Slot structure</td>
<td>2 HDTV programs are multi-plexed into 1 transponder</td>
</tr>
<tr>
<td></td>
<td>- Trellis+RS (Concatenated coding)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Single carrier 8 PSK modulation</td>
<td></td>
</tr>
<tr>
<td>Terrestrial TV (STD-B31)</td>
<td>- Segment structure</td>
<td>1 segment transmission is available</td>
</tr>
<tr>
<td></td>
<td>- Viterbi+RS (Concatenated coding)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Multi-carrier (OFDM) transmission</td>
<td></td>
</tr>
<tr>
<td>Terrestrial Audio (STD-B29)</td>
<td>- 1 and 3 segment transmission</td>
<td>1 segment system is compatible to 1 segment of TV</td>
</tr>
<tr>
<td></td>
<td>- Others are almost same as STD-B31</td>
<td></td>
</tr>
<tr>
<td>Satellite Audio (STD-B42)</td>
<td>- Multiplex 64 CDM channel</td>
<td>Adopt “AAC+SBR” 2.6GHz Band</td>
</tr>
<tr>
<td></td>
<td>- Viterbi+RS (Concatenated coding)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- CDM-BPSK/QPSK transmission</td>
<td></td>
</tr>
</tbody>
</table>
Outlines of Standards (continued)

What is the operational guideline?
All the technical elements required are written in ARIB STD. But, the
details for operation of broadcasting are defined separately, even
though based on ARIB STD. These documents are called “Operational
Guideline”

Examples
ARIB TR-B13; Terrestrial Audio broadcasting operational guideline
ARIB TR-B14; Terrestrial TV broadcasting operational guideline
ARIB TR-B15; BS/wideband CS broadcasting operational guideline
ARIB TR-B26; Satellite Audio broadcasting operational guideline

4. Technical Details of ISDB-T

4.1 Structure of Japan’s Digital Broadcasting System
4.2 ISDB-T Transmission System
4.3 ISDB-T Multiplex system
4.4 Video Coding
4.5 Audio Coding
4.6 Data casting
4.7 Video Coding for One-seg service
### 4.1 Structure of Japan’s Digital Broadcasting system

- **Multiplex (Based on MPEG-2 systems)**
  - Single carrier 8-PSK/PSK
  - Single carrier 64QAM
  - Segmented OFDM QAM/DQPSK With time interleave

- **Source coding**
  - MPEG-2 Video coding
  - MPEG-AAC Audio coding
  - Data coding (note)
  - H.264 video coding

- **Multiplex**
  - Common interface (Transport Stream interface)

- **Transmission coding**
  - Common interface (Framed Transport Stream interface)

**One segment handheld service**

**Fixed/mobile service**

**Layer A** (LDTV, Audio, Data)

**Layer B** (HDTV or 3 SDTV with Data)

Handheld reception (One seg. Service)

Fixed reception, Mobile reception (HDTV, etc)

- **7 segments** (6MHz bandwidth)

**Feature of Japan’s Digital Broadcasting system**

1. **Flexibility of service**: Interface between source coding and Multiplex is common interface (Transport Stream interface), so, any contents based on TS can be available.
2. **Flexibility of transmission media**: Optimized to each transmission media.
3. **Terrestrial transmission system**: For any reception type, such as fixed/mobile/handheld, adopt Segmented OFDM with time interleave (see next page)

**What is Segmented OFDM with time interleave?**

- Segmented OFDM: Possible to support fixed/mobile/handheld reception service
- Time interleave: reduce impulse noise and reduce the degradation caused by fading (tested in Brazil by Mackenzie and TV GLOBO)
4.2 ISDB-T transmission system

- Features of transmission system

1. Efficient frequency utilization
   (1) Adopt OFDM transmission system; SFN operation
   (2) Adopt hierarchical transmission; service for different type of reception in one frequency channel

2. Mobile/ handheld service in one transmission standard
   (1) Time interleave; Improve mobile reception quality
   (2) Partial reception; handheld service in same channel

3. Robustness against interference
   (1) Adopt concatenated error correction with plural interleave
   (2) Time interleave; very effective for impulse noise (urban noise)

4. Flexibility for several type of service/ reception style

5. Commonality of TV/audio transmission standard

6. Auxiliary (AC) channel can be used for transmission network management

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### Parameters of ISDB-T (6MHz Bandwidth)

<table>
<thead>
<tr>
<th>ISDB-T mode</th>
<th>Mode 1 (2k)</th>
<th>Mode 2 (4k)</th>
<th>Mode 3 (8k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of OFDM segment</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Useful bandwidth</td>
<td>5.575MHz</td>
<td>5.573MHz</td>
<td>5.572MHz</td>
</tr>
<tr>
<td>Carrier spacing</td>
<td>3.968kHz</td>
<td>1.984kHz</td>
<td>0.992kHz</td>
</tr>
<tr>
<td>Total carriers</td>
<td>1405</td>
<td>2809</td>
<td>4992</td>
</tr>
<tr>
<td>Modulation</td>
<td>QPSK, 16QAM, 64QAM, DQPSK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of symbols / frame</td>
<td>204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active symbol duration</td>
<td>252 (\mu\text{s})</td>
<td>504 (\mu\text{s})</td>
<td>1.008ms</td>
</tr>
<tr>
<td>Guard interval duration</td>
<td>1/4, 1/8, 1/16, 1/32 of active symbol duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inner code</td>
<td>Convolutional code (1/2, 2/3, 3/4, 5/6, 7/8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer code</td>
<td>RS (204,188)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time interleave</td>
<td>0 ~ 0.5s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Useful bit rate</td>
<td>3.651Mbps ~ 23.234Mbps</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Feature of Japanese DTTB system

- Support 3 reception type by one channel
- Fixed Reception
- Mobile/Handheld Reception
- Communication/Internet
- Handheld terminal
- Receiver in Vehicle

(1) Hierarchical transmission

- Maximally 3 Layer transmission in one Transport Stream
- Any combination of transmission parameter is available for each layer
Example of 2 programs into 3 layers

ISDB-T Re multiplexer

Layer A

Layer B

Layer C

Image of multiple layer transmission

Blockdiagram of TS re-multiplexer
(2) Transmission coding

- Concatenated Error Correction System; Convolutional+Reed-Solomon
- 4 kinds of Interleave; Byte/Bit/Time/Frequency
- 4 kinds of Modulation Parameters; QPSK/DQPSK/16QAM/64QAM

Any kinds of coding rate and modulation parameters can be set for each layer independently.

Kind of interleave and these effect:

- **Byte interleave**
  Byte interleave is located between outer coder and inner coder. Randomize the burst error of Viterbi decoder output.

- **Bit interleave**
  Bit interleave is located between convolutional coding and mapping. Randomize the symbol error before Viterbi decoding.

- **Time interleave**
  Time interleave is located at the output of time interleave. Randomize the burst error of time domain which is mainly caused by impulse noise, fading of mobile reception, etc.

- **Frequency interleave**
  Frequency interleave is located at the output of mapping. Randomize the burst error of frequency domain which is mainly caused by multi-path, carrier interference, etc.
(3) OFDM Modulation

- 3 kinds of OFDM Modulation: 2k, 4k, 8k
- 4 Kinds of Guard Interval Length: 1/32, 1/16, 1/8, 1/4

Effect of time interleave

- **no time interleave**
  - Transmitter delay
  - Transmitter side
  - time
  - field strength varied

- **With time interleave**
  - Receiving delay

Time Interleave is effective not only for signal level fluctuation but also for impulse interference

- Burst error
- Error randomized

- (After de-interleave)
Example of OFDM signal waveform

TV signal spectrum
4.3 Multiplex system

- Functions
  - Function of Multiplex
    - Multiplex plural services/program/component on transmission
    - Signal format is common for any kind of service, program and component
    - Free from transmission media
  - Function of synchronization
    - Synchronization between transmission side and receiving side
    - Synchronization between program component (video, audio)
  - Function of selection
    - Service information for selection of service and program

- Features
  - Flexibility
    - Support any service, program and component
  - Expandability
    - Applicable for new program component

Digital broadcasting & Multiplex system

Signal format of digital broadcasting

(note) signal format of PES, TS and Section area is defined in ARIB STD-B32, based on MPEG-2 systems
(note) PSI is defined in both STD-B32 and STD B10. In STD-B32, only outline related to MPEG-2 systems is defined
MPEG-2 Systems
TS multiplexing method

184 byte

Video PES
header

188 byte

Audio PES
header

TS

PSI/SI
relationship between PSI and SI

<table>
<thead>
<tr>
<th>function</th>
<th>PSI</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support plural TS</td>
<td>Signal selection from MPEG-2 TS</td>
<td>Support the program selection</td>
</tr>
<tr>
<td>Time schedule support</td>
<td>identify by TS_id only</td>
<td>yes (broadcasting for plural TS)</td>
</tr>
<tr>
<td></td>
<td>none</td>
<td>yes (program)</td>
</tr>
<tr>
<td>Information format</td>
<td>table</td>
<td>table</td>
</tr>
<tr>
<td>Signal format</td>
<td>section</td>
<td>section</td>
</tr>
<tr>
<td>Transmission style</td>
<td>Transmit repeatedly</td>
<td>Transmit repeatedly</td>
</tr>
<tr>
<td>specification</td>
<td>ISO/IEC 13818-1</td>
<td>ARIB STD-B10</td>
</tr>
<tr>
<td>reference</td>
<td>-</td>
<td>ISO/IEC 13818-1</td>
</tr>
<tr>
<td>scope</td>
<td>Used for any media</td>
<td>broadcasting</td>
</tr>
</tbody>
</table>

Based on PSI, extend for broadcast service
Function of SI

- Supplement of PSI, control the receiver
- Function of EPG (Electronic Program Guide); see below

Example of BS digital Broadcasting, for DTBB EPG is given by each broadcaster separately

---

4.4 Video Coding System

In Japan, HDTV had been developed since 1980’s, and analog HDTV trial service, named MUSE, has already started. Because of this situation, video coding system for DTV should support many video format and has capability of video format change according to display aspect ratio.

because of above reasons, specifications of video coding should have following features

1. Video coding system; adopt most popular system **MPEG2**
2. Support many types of video format; **480i/480p/1080i/720p**
3. Specify the relationship of video source and display aspect ratio

Video coding system is specified in ARIB STD-B32 Part 1 (note)

(note) Video coding system for LDTV is specified in ARIB STD-B24 separately
(a) Outline of video coding

(1) Compression system; MPEG2 (MP@HL)
(2) Video format

<table>
<thead>
<tr>
<th>No. of line</th>
<th>No. of pixel</th>
<th>quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080i</td>
<td>1920*1080</td>
<td>HDTV (interlace)</td>
</tr>
<tr>
<td>720p</td>
<td>1440*720</td>
<td>HDTV (progressive)</td>
</tr>
<tr>
<td>480p</td>
<td>720*480</td>
<td>SDTV (progressive)</td>
</tr>
<tr>
<td>480i</td>
<td>720*480</td>
<td>SDTV (interlace)</td>
</tr>
</tbody>
</table>

D terminal: D1:480i, D2:480p, D3:1080i, D4:720p
(b) Actual video bit rate

<table>
<thead>
<tr>
<th>No. of line</th>
<th>profile</th>
<th>actual bit rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080i</td>
<td>MP@HL</td>
<td>BS:12-24Mbps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DTTB:8-20Mbps</td>
</tr>
<tr>
<td>720p</td>
<td>MP@H-14</td>
<td>BS:4-24Mbps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DTTB:4-20Mbps</td>
</tr>
<tr>
<td>480p</td>
<td>MP@H-14</td>
<td>BS:4-24Mbps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DTTB:4-20Mbps</td>
</tr>
<tr>
<td>480i</td>
<td>720*480</td>
<td>1.5-15Mbps</td>
</tr>
<tr>
<td>240p</td>
<td>720*480</td>
<td>0.2-4Mbps</td>
</tr>
</tbody>
</table>

4.5 Audio Coding System

(a) Audio Input Format

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio mode</td>
<td>Possible audio modes: Monaural, stereo, multichannel stereo (3/0, 2/1, 3/1, 2/2, 3/2, 3/2+LFE) (Note 1), 2-audio signals (dual monaural), multi-audio (3 or more audio signals) and combinations of the above</td>
</tr>
<tr>
<td>Recommended audio mode</td>
<td>Monaural, stereo, multichannel stereo (3/1, 3/2, 3/2+LFE) (Note 2), 2-audio signals (dual monaural)</td>
</tr>
<tr>
<td>Emphasis</td>
<td>None</td>
</tr>
</tbody>
</table>

(Note 1) Number of channels to front/rear speakers: Example: 3/1 = 3 front + 1 rear
3/2 = 3 front and 2 rear

(Note 2) LFE = Low frequency enhancement channel

ARIB STD-B32 part 2 Chapter 5.1
(b) Main parameters of audio coding

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit stream format</td>
<td>AAC Audio Data Transport Stream (ADTS)</td>
</tr>
<tr>
<td>Profile</td>
<td>Low Complexity (LC) profile</td>
</tr>
<tr>
<td>Max. number of coded channels</td>
<td>5.1 channels (Note) max. per ADTS</td>
</tr>
<tr>
<td>Max. bit rate</td>
<td>As per ISO/IEC 13818-7</td>
</tr>
</tbody>
</table>

(Note) 5 channels + LFE channel

ARIB STD-B32 part 2 Chapter 5.2

AAC encoder Block Diagram

Input time signal

Perceptual Model

Pre-Processing

Filter Bank

Rate/Distortion Control Process

Quantized Spectrum of Previous Frame

Rate/Distortion Control Process

Quantized

Bitstream Formatter

AAC: advanced audio coding
4.6 Data casting

Data Composition

MPEG2 Audio and Video

MUX

Data A  Data B  Data C  Data A

Each data broadcast as module repeatedly. Same module will appear in some period. (MPEG / DSM-CC Data Carousel)
Data Broadcasting

All DTTB Broadcasters and BS Broadcasters providing Data broadcasting (datacast) now

<table>
<thead>
<tr>
<th>Program related information</th>
<th>Anytime news</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather information</td>
<td>Report of sports game etc,</td>
</tr>
</tbody>
</table>

Currently the description language is BML format

Based on

BML
Functions for Broadcasting

XHTML

Features
Easy creation of contents
Facilitate convergence of internet

Example for Datacasting(1)

Top menu
Example for Datacasting(2)

Weather news

Example for Datacasting(3)

Program related data
ARIB STD-B24

• B24 consist of three volumes (four books)
  – Volume 1: Mono media
  – Volume 3: Transmission

• Volume 2 consist of six parts
  – Main context (Standard)
  – Appendix 1 (Supplement of standard)
  – Appendix 2 (Basic profile)
  – Appendix 3 (Advanced profile)
  – Appendix 4 (Profile for Mobile phone)
  – Appendix 5 (Profile for Vehicle)

Overview of datacasting services

• Example of services
  – EPG: TV Program selection
  – Index: Choice of TV program, contents
  – Subtitle: Synopsis subtitle, multi-language
  – Commentary audio: for vision-impaired
  – Program supplemental information: Additional information of TV Program (ex. brief)
  – Multi-view television (Multi angle)
  – User interaction program: Shopping, Questionnaire

See STD B24 Vol.1 Informative explanation 1
BML

- Multimedia data representation coding scheme for Digital broadcasting
  - Specified in XML
  - Textual notation
  - Extension for broadcasting feature
- XHTML1.0 + ECMAScript + CSS1/2 + DOM1+ Broadcast Extension
  - All component defined by W3C, which is main stream for the internet content specification.
  - Difference between broadcast content and internet content
    - Bi-directional communication
    - Hardware platform (CE vs PC)

---

Difference between BML and HTML

<table>
<thead>
<tr>
<th>Sample</th>
<th>BML</th>
<th>HTML</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1" alt="BML Sample" /></td>
<td><img src="image2" alt="HTML Sample" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature</th>
<th>BML</th>
<th>HTML</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Few hyperlinks per one screen</td>
<td>Many hyperlinks in one screen</td>
</tr>
<tr>
<td></td>
<td>Intuitive providing information by using bitmap and video</td>
<td>Text centric information providing by small letter presentation</td>
</tr>
<tr>
<td></td>
<td>Scroll is optional</td>
<td>Suppose to scroll functionality</td>
</tr>
<tr>
<td></td>
<td>Update latest information automatically</td>
<td>Need to push “reload” button for retrieving latest information generally</td>
</tr>
<tr>
<td></td>
<td>Synchronize between TV and Radio program</td>
<td></td>
</tr>
</tbody>
</table>
4.7 Video Coding for “One-seg” Service

• Video coding system; H.264/AVC (ITU-T Rec. H264|ISO/IEC 14496-10)

• Specified in ARIB-STD-B24, as one of Mono-media coding system

• Specified in Operational Guideline (TR-B14), as Video coding system for “One Seg” service

---

**EXAMPLE**

Recommended Operational Guideline for Baseline Profile (ARIB STD-B24 ANNEX G)

• Associated service requirement
  (1) Bitrate; 64 – 384 Kbps
  (2) Video format; SQVGA, 525QSIF, QCIF, QVGA, 525SIF, CIF
  (3) Frame rate; 5, 10, 12, 15, 24, 30 Hz (*1000/1001), no limitation for frame skip
  (4) Aspect ratio of picture; 4:3, 16:9

• Operation level; any of level 1, 1.1, 1.2

Parameter set of One-Seg broadcasting service
One Seg Service video coding parameter set

<table>
<thead>
<tr>
<th>parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coding system</td>
<td>H264/AVC</td>
</tr>
<tr>
<td>Profile/level</td>
<td>Baseline profile, level 1.2</td>
</tr>
</tbody>
</table>
| Video format        | • 320 Pixel * 240 line, or 320 pixel * 180 line
|                     | • Aspect ratio of pixel; 1:1
|                     | • Minimum frame period; 1/15 second (video source; 30fps, or 24 fps) |
| others              | Compatible to ARIB STD-B24 (specified in ARIB TR-B14) |

5. Commonality with Narrow-band ISDB-T(ISDB-Tsb) (ARIB STD-B29)

1. ISDB-Tsb Transmission System
2. Consecutive Transmission System
3. Experimental Broadcasting Infrastructure
4. Examples of Prototype Receiver and Service
1. ISDB-T_{SB} transmission system

(1) What is ISDB-T_{SB}

ISDB-TSB transmission system is unique in ISDB-T family. This transmission system has been standardized for narrow band ISDB-T transmission system, which is focused to audio and data service, therefore, called ISDB-TSB.

(2) Commonality with ISDB-T

(a) Same segment transmission construction. But, considering narrow band reception, only 1 segment and 3 segment transmission systems are standardized

(b) Adopt same transmission parameters as ISDB-T.

(c) Commonality of 1 segment receiver with ISDB-T partial reception

(3) Efficient use of frequency resource

(a) Consecutive transmission system. This system is unique for ISDB-TSB, this transmission system is to transmit plural channel without guard band

(b) To achieve consecutive transmission, phase compensation technology at transmitter side is adopted

Digital radio/digital TV compatible receiver
Spectrum of 1 segment system and 3 segment system

Transmission parameters

<table>
<thead>
<tr>
<th>Mode</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment(s)</td>
<td>1 or 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>430kHz or 1.3MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrier spacing</td>
<td>3.97kHz</td>
<td>1.98kHz</td>
<td>0.99kHz</td>
</tr>
<tr>
<td>Total carriers</td>
<td>109 / 325</td>
<td>217 / 649</td>
<td>433 / 1297</td>
</tr>
<tr>
<td>Data carriers</td>
<td>96 / 288</td>
<td>192 / 576</td>
<td>384 / 1152</td>
</tr>
<tr>
<td>TMCC,AC,CP, SP carriers</td>
<td>13 / 37</td>
<td>25 / 73</td>
<td>49 / 145</td>
</tr>
<tr>
<td>Modulation</td>
<td>QPSK, 16QAM, 64QAM, DQPSK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Spectrum utilization (2)

Consecutive-segment Transmission of DSB channels

Transmission from single transmitter keeping OFDM -condition

Example of allocation

430kHz 1.3MHz

Conventional allocation

Guard bands

430kHz 1.3MHz

Frequency utilization efficiency will be improved up to 150%.

Trial Services of DRP

VHF television band assignments

VHF 6ch  VHF 7ch  VHF 8ch

6MH  188MH  192MH

2MHz(Overlapping)

Segment structure

1 2 3 4 5 6 7 8

3seg. broadcasting

8 segments (Normally 13seg.)

Broadcast programs

91ch 92ch 93ch 94ch 95ch

Above example is Tokyo station, Osaka's all programs are 1seg. broadcasting.
Image of consecutive transmission and reception

Details of ISDB-TSB transmitter block diagram

After RE-MUX, frame and clock of each channel are synchronized
DRP Tokyo master rack room

DRP Tokyo digital radio transmitter room
Antenna

- DTTB transmission Antenna (UHF band)
- MX TV antenna
- Digital radio Transmission Antenna
- Special observation deck

DRP prototype receiver (1 segment)
PDA type prototype receiver (KDDI/TFM/Vitec)

Pixela PC card type receiver
**PC card type receiver (test product)**

---

### Digital radio trial broadcasting

**Channel construction**

Tokyo 

<table>
<thead>
<tr>
<th>Year</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>NHK VICS</td>
</tr>
<tr>
<td>92</td>
<td>DR@ TOKYO92</td>
</tr>
<tr>
<td>93</td>
<td>DigiQ+ N93</td>
</tr>
<tr>
<td>94</td>
<td>DAZ94</td>
</tr>
<tr>
<td>95</td>
<td>D95</td>
</tr>
<tr>
<td>98</td>
<td>Digital Radio 98 The Voice</td>
</tr>
</tbody>
</table>

- **NHK VICS**
  - FM Yokohama
  - TBS radio
  - Comunications
  - BAYFM
  - Radio NIKKEII

- **Services**
  - NACK5
  - QR TV asahi (B member)
  - J-WAVE
  - Mega-port Radio NIPPON
  - Ito-chu SONY
  - TOKYO FM
  - NIPPON broadcasting
  - JFNC (B member)
Example of DTSB service

Thank You for Your Attention

Digital Broadcasting Expert Group

http://www.dibeg.org/
mail; info@dibeg.org