ISDB-T: Japanese Digital Terrestrial Television Broadcasting (DTTB)

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คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

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ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB)
Features of ISDB-T

- High quality TV (HDTV) and sound or Multi-broadcasting program
- Robustness for interferences
  - OFDM
  - Time and frequency interleaving technology (for Vehicular receivers)
- Hierarchical transmission up to 3 layers
  - Modulation, coding rates, length of time interleaving
  - Parameters are sent in TMCC (transmission and multiplexing configuration control) signal
- Multimedia Services
  - Data broadcasting: Regional information service
  - Interaction: Quizzes, questionnaires, requests, voting
  - Combined with communication services
- Inter-operability with Other Broadcasting Media
  - ISDB-S (for satellite) and ISDB-C (for cable)
- Partial reception with handheld receivers
  - Simultaneous with HDTV service
- Mobile reception with vehicular receivers
- SFN (Single Frequency Network) Operation
## Outline of ISDB-T transmission scheme

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</tr>
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<td>Multi 2</td>
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<td>---</td>
</tr>
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<td>ISDB-T transmission</td>
<td></td>
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</tr>
<tr>
<td><strong>Channel Bandwidth</strong></td>
<td>6MHz, 7MHz, 8MHz</td>
<td></td>
<td></td>
</tr>
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<td><strong>Modulation</strong></td>
<td>Segmented OFDM (13 segment/ch)</td>
<td></td>
<td></td>
</tr>
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<td><strong>Mode, Guard</strong></td>
<td>Mode: 1, 2, 3 Guard Interval Ratio: 1/4, 1/8, 1/16, 1/32</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carrier Modulation</strong></td>
<td>QPSK, 16QAM, 64QAM, DQPSK</td>
<td>STD-B31</td>
<td>BT.1306 System C</td>
</tr>
<tr>
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<td>Inner Convolutional code (Coding rate: 1/2, 2/3, 3/4, 5/6, 7/8)</td>
<td></td>
<td></td>
</tr>
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<td>Outer (204, 188) Reed-Solomon code</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Interleave</strong></td>
<td>Frequency and Time Interleave</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Interleave : 0 - 0.5 sec</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **Information bit rate** | 6MHz : 3.7 - 23.2 Mbit/s  
7MHz : 4.3 - 27.1 Mbit/s  
8MHz : 4.9 - 31.0 Mbit/s |                |                        |
| **Receiver**          | ISDB-T receiver                                                         | STD-B21        | ---                    |
| **Operational guideline** | ISDB-T broadcasting operation                                         | TR-B14         | ---                    |

ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB)
## ISDB-T Main Specifications

- **Hierarchical transmission**
  - Transmission segment groups with different transmission parameters
  - Maximum of three layers can be transmitted simultaneously in a channel
  - Possible to select parameters to adjust services such as HDTV, vehicular and so on

### ISDB-T in Japanese 6MHz system

<table>
<thead>
<tr>
<th>Transmission Parameter</th>
<th>Mode 1</th>
<th>Mode 2</th>
<th>Mode 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of OFDM segments</strong></td>
<td></td>
<td></td>
<td><strong>13</strong></td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>5.575 MHz</td>
<td>5.573 MHz</td>
<td>5.572 MHz</td>
</tr>
<tr>
<td><strong>Carrier interval</strong></td>
<td>3.968 kHz</td>
<td>1.984 kHz</td>
<td>0.992 kHz</td>
</tr>
<tr>
<td><strong>No. of carriers</strong></td>
<td>1405</td>
<td>2809</td>
<td>5617</td>
</tr>
<tr>
<td><strong>Carrier modulation</strong></td>
<td>QPSK, 16QAM, 64QAM, DQPSK</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Effective symbol length</strong></td>
<td>252 μs</td>
<td>504 μs</td>
<td>1.008 ms</td>
</tr>
<tr>
<td><strong>Guard-interval length</strong></td>
<td>1/4, 1/8, 1/16, 1/32 of effective symbol length</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>No. of symbols per frame</strong></td>
<td></td>
<td></td>
<td>204</td>
</tr>
<tr>
<td><strong>Time interleave</strong></td>
<td></td>
<td>Maximum 4 values : 0, 0.1, 0.2, 0.4 sec</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency interleave</strong></td>
<td></td>
<td>Intra-segment and inter-segment interleaving</td>
<td></td>
</tr>
<tr>
<td><strong>Inner code</strong></td>
<td></td>
<td>Convolutional coding (1/2, 2/3, 3/4, 5/6, 7/8)</td>
<td></td>
</tr>
<tr>
<td><strong>Outer code</strong></td>
<td></td>
<td>RS (204, 188)</td>
<td></td>
</tr>
<tr>
<td><strong>Information bit rate</strong></td>
<td></td>
<td>3.65 Mbps - 23.23 Mbps</td>
<td></td>
</tr>
<tr>
<td><strong>Hierarchical transmission</strong></td>
<td></td>
<td></td>
<td>Maximum 3 levels (Layer A, B, and C)</td>
</tr>
</tbody>
</table>
Receiving environment for terrestrial TV broadcasting

Fixed reception

Vehicular reception

Handheld reception

• Multipath interference
• Fading interference
• Impulse, man-made noise
• Shadowing

Receiving environment is very severe.
Signal degradation due to Multipath

- **OFDM Modulated signal**
  \[ s(t) = Ae^{-j2\pi ft} \]

- **Multipath signal**
  \[ u(t) = \rho Ae^{-j2\pi f(t-\tau)} \]

- **Received signal**
  \[ s(t) + u(t) = Ae^{-j2\pi ft} + \rho Ae^{-j2\pi f(t-\tau)} = Ae^{-j2\pi ft} \left\{ 1 + \rho e^{j2\pi f\tau} \right\} \]

- \[ 2\pi f\tau = 2k\pi \quad (f = k/\tau) \]
  amplitude of received signal decreases

Power of specific sub-carrier decreases

Degradation of C/N of specific sub-carrier

*Official Information: NHK Science and Technology Research labs, Japan*
Key technologies for ISDB-T

- To overcome the terrestrial severe receiving environment
  - OFDM
  - Frequency & Time-interleaving

- To realize the effective and smart transmission
  - **Hierarchical transmission** by Band Segmented Transmission OFDM
    - Realization of One-Segment service for handheld reception
Digital Transmission Diagram

- Information coding 
- Error Correction coding 
- Digital Modulation 
- Transmitter 
- Bit stream 
- Digital Modulated Signal 
- Channel 
- Receiver 
- Received Info. 
- Information Decoding 
- Error correction decoding 
- Digital Demodulation 

ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB)
ISDB-T Configuration

TS: Transport stream

MPEG-2 MUX

TS Re-mux

RScoding (204,188)

Carrier modulation

Bit interleave mapping

Division Into HL

HL: Hierarchical Level

Carrier modulation

Bit interleave mapping

Carrier modulation

Bit interleave mapping

TS

Re-mux

Convolution coding

Energy dispersal

Delay compensate

Byte interleave

Bit

Byte

Byte interleave

Convolution coding

Time interleave

Frequency interleave

OFDM Frame Construction

IFFT

Adding Guard interval

Pilot Signal

TMCC Signal

*Official Information: ARIB STD-B31 version 1.6
OFDM is

- Multi-carrier modulation
  - More than 2,000 carriers in a 6MHz TV channel
  - Long symbol duration compared to single-carrier transmission system

- Multipath proof modulation
  - By adding guard interval

- Modulation/demodulation can be processed by IFFT/FFT.
Example of OFDM Spectrum

UHF 27ch

UHF 20~27ch

*Official Information: NHK Science and Technology Research labs, Japan
**OFDM Signal (Frequency domain)**

- Carrier Modulation: QPSK, QAM, etc.
- Different modulation techniques on each carrier is possible.

![OFDM Signal Diagram]

- PSK, QAM, etc.
**Conceptual Model of OFDM Signal**

Relationship between OFDM Carriers and Symbols

- **Carrier #1**
- **Carrier #k**

*Official Information: NHK Science and Technology Research labs, Japan*
Scattered Pilot (SP) signal

Carrier direction (frequency)

Symbol direction (time)

●: SP
○: data
Mapping of Scattered Pilot (SP) signal

(ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB))

(RMS value $16QAM$ is $\sqrt{10}$, while the value of SP is $(+4/3\sqrt{10}, 0)$ or $(-4/3\sqrt{10}, 0)$)
Demodulation of OFDM Signal

Signal Constellation

Transmitted signal

Received signal

Demodulation of OFDM Signal

Carrier #k

Reference symbol

Current symbol

Compare to reference symbol

Received signal

Prediction
Guard Interval

- Copy the last part and add to the front of symbol
- Reduce the effect of multipath delay signal if delay is smaller than TG
Guard Interval and Multipath (the same phase)

symbol # (N - 1)  symbol # N  symbol # (N + 1)

Main signal:
\[ g(t) \]

Reflected signal:
\[ r \cdot g(t - \tau) \]

Received signal:
\[ g(t) + r \cdot g(t - \tau) \]

Guard Interval

Effective symbol

FFT
Guard Interval and Multipath
(opposite phase)

symbol # (N - 1)  symbol # N  symbol # (N + 1)

Main signal
\( g(t) \)

Guard interval

Effective symbol

Reflected signal
\( r \cdot g(t - \tau) \)

Received signal
\( g(t) + r \cdot g(t - \tau) \)

\( \tau \)

FFT
Frequency and time interleaving (I)

Original data

Frequency interleaving (Carrier randomization)

Time domain (Symbols)

Following interleaving adopts only multi-carrier transmission system

OFDM signal

Time interleaving (Symbol randomization)

Suitable for multipath interference. But, ineffective to flat-fading and impulse noise.

ISDB-T

Frequency & Time interleaving

(Carrier & Symbol randomization)

Suitable for fading and impulse interference. But, ineffective to multipath interference.

Suitable for all kinds of interference.

*Official Information: NHK Science and Technology Research labs, Japan
Frequency and time interleaving (II)

Frequency & Time interleaving
(Carrier & Symbol randomization)

Transmission

Burst errors

De-interleave

Random errors

Multipath interference
(Frequency selective interference)

Flat fading or impulse noise,
Transmission errors

Original data

Error correct

2-dimentional Random errors
Suitable for Viterbi and Reed-Solomon error correction

*Official Information: NHK Science and Technology Research labs, Japan
**Effect of Frequency and Time Interleaving**

**Laboratory test results**

flat fading, DQPSK, Mode=1, GI=1/8, FEC=1/2, RS=OFF

![Graph showing the effect of frequency and time interleaving on BER vs. C/N](image)

**Without time interleaver**

(Fd = 7 Hz, Fd = 20 Hz, Fd = 70 Hz)

**Without time-interleaver** *(Error remains even in high C/N)*

**With time-interleaver** *(No error at more than C/N=20dB)*

*Official Information: NHK Science and Technology Research labs, Japan*
Effect of Frequency and Time Interleaving

Time Interleave Technology

TV Station

ISDB-T
Time Interleave

Sort data in accordance with set rules

Original date

ATSC
DVB-T
No Time Interleave

Transmission Path

Errors occur as a result of radio interference

Reconstruction of data

Dispersed errors can be corrected.

Receivers

Errors occur as a result of radio interference

Difficult to correct continuous errors.

*Official Information: NHK Science and Technology Research labs, Japan
Hierarchical Transmission Examples

Digital Terrestrial Television Broadcasting (ISDB-T)

1-segment Service (Partial reception)

HDTV Program

1-segment Service (Partial reception)

SDTV for Mobile Reception

SDTV for fixed Reception

Multiplexing

Layer B
Layer A

Layer C
Layer B
Layer A

Spectrum

5.6 MHz

OFDM Segments

Audio Program
Audio Program
Data

429 kHz
1.3 MHz

Fixed / vehicular Receiver

handheld Receiver

*Official Information: NHK Science and Technology Research labs, Japan
Broadcasting Services By ISDB-T

Advanced Features of ISDB-T

**HDTV**
- High quality image and sound service

**Multi-Channel Service**
- Realization of multi-SDTV program service on 1ch bandwidth (6MHz)

**Interactive TV**
- Communication linked services with TV

**Data Broadcasting**
- Simple retrieval of program and information at any time

**Mobile Reception**
- HD TV and Mobile TV in vehicle
- Mobile TV on Handheld Reception like Cell phones, Portable Game machine and so on.

*Official Information: Ministry of Internal Affairs and Communications, Japan*
Multi-broadcasting and Multi-view Services

Example (MPEG2)

Pattern A

1CH bandwidth

1HDTV + 1 Mobile TV

Pattern B

SDTV 4 ch + Mobile TV

Pattern D

8 SDTV + 2 Mobile TV

Example (MPEG4)

Pattern A

2HDTV + 1 Mobile TV

Pattern B

4SDTV + 1 Mobile TV + 1HD

Pattern D

8 SDTV + 2 Mobile TV
### Flexibility of TV Program Planning with ISDB-T

**ISDB-T’s Flexibility can provide various combination of programs.**

<table>
<thead>
<tr>
<th>Time</th>
<th>SDTV (Sport shows football)</th>
<th>SDTV (Variety shows)</th>
<th>SDTV (Dramas shows)</th>
<th>SDTV (Sport shows Basketball)</th>
</tr>
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<tbody>
<tr>
<td>18:00</td>
<td>Football</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19:00</td>
<td>Football</td>
<td>Football</td>
<td>Football</td>
<td></td>
</tr>
<tr>
<td>20:00</td>
<td>HDTV Movie (low bit rate)</td>
<td>SDTV (Sport shows Basketball)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21:00</td>
<td>HDTV Movie</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mobile TV services (One-Seg)**
ISDB-T One-Seg Handheld Receivers

Service commenced in April 2006

Lineup of ISDB-T mobile TV receivers

- GSM+3G mobile Phones in Brazil
- Mobile Phones
- Car Navigators
- Portable Dictionary
- PCs with One-Seg
- Portable Games
- Portable Players
- USB type One-Seg tuners

A large variety of mobile TV receivers attract new viewers.

*Official Information: NHK Science and Technology Research labs, Japan
Service Model of One-Segment Service for Mobile Communication Terminals

- Various types of services can be realized using functionalities combining One-segment service reception and mobile communication

**Linkage from broadcasting to communication**

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<th>Broadcasting program view</th>
<th>Data broadcasting view</th>
<th>Mobile data online</th>
<th>Link to web sites</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Broadcasting program view" /></td>
<td><img src="image2" alt="Data broadcasting view" /></td>
<td><img src="image3" alt="Mobile data online" /></td>
<td><img src="image4" alt="Link to web sites" /></td>
</tr>
<tr>
<td><strong>Receive and watch TV program via Broadcasting</strong></td>
<td><strong>Receive and browse data broadcasting via Broadcasting</strong></td>
<td><strong>TV program is received via Broadcasting (top), data is received via mobile Internet (bottom)</strong></td>
<td><strong>Mobile Internet services of various provider</strong></td>
</tr>
</tbody>
</table>

*Official Information: NHK Science and Technology Research labs, Japan*
Interactive TV Service

ISDB-T can provide Interactive TV service

High functionality

Data Broadcasting

- Weather forecast
- News
- Information linked to on-air program

Interactive TV over 51 million receivers, e.g. interactive shopping

You can see the items and you can buy them directly.

Only ISDB-T succeeds those New businesses

DVB-T hasn’t provided attractive services of Data-broadcast and interactivity

*Official Information: Ministry of Internal Affairs and Communications, Japan
Emergency Warning System (for Human life)

People can get Emergency Warning under such inclement conditions as typhoons and tsunamis. Many lives would be saved with ISDB-T.

EWS test signals are monthly broadcasted in Japan.

*Official Information: NHK Science and Technology Research labs, Japan
Mobile TV is the Best in case of Disaster

Mobile TV is the Best tool to inform people of emergency information in case of Disaster

In case of Disaster, traffic congestion in mobile telephone network disable its services. In contrast, mobile TV by ISDB-T tolerates disaster damage and enables service continuation.

People can receive important information Anytime Anywhere.

Information of Disaster

Mobile telephone line is not available, but I can get necessary information via Mobile TV!!

Evacuate from this area!
Activation Flag for Handheld Receivers in ISDB-T

ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB)
EWS low power consumption technology for Handheld Receivers

Small prototype receiver that detects the activation flag for alert broadcasting

Cell phone being connected to small prototype receiver

*Official Information: NHK Science and Technology Research labs, Japan
**HDTV vehicular reception technology for ISDB-T**

- **Conventional reception**
  - Robust modulation (16QAM ½ or QPSK)
  - 1 receiving antenna
  - **SDTV**

- **Diversity reception**
  - 64QAM (transmission same as in fixed reception)
  - 2-4 branches (number of receiving antennas)
  - **HDTV**

- **Diversity reception technology for motor vehicles**
  - Space diversity
  - HDTV programs are available in a vehicle with high quality, clear and noiseless image
  - A HDTV vehicular system based on the diversity reception technology is already on sale in Japan

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*Official Information: NHK Science and Technology Research labs, Japan*
### Diversity reception system for vehicular reception

- After multiplying weight vector, the signals at each branch are diversity combined for each sub-carrier to **maximize the C/N in each sub-carrier**
- The weight vector is computed from scattered pilot (SP) signals contained in the ISDB-T signal

---

**Block diagram of diversity reception system**

- **Branches**: #1, #2, #3, #4
- **Spectra of receiving OFDM signal**
- **Weight vector**: $C_1(0)$, $C_1(k-1)$, $C_2(0)$, $C_2(k-1)$, $C_3(0)$, $C_3(k-1)$, $C_4(0)$, $C_4(k-1)$
- **Output signals**: $D(0)$, $D(i)$, $D(k-1)$

---

**Spectrum of diversity combined signal**
Result of vehicular reception field experiment

- ISDB-T: 标准数字广播电视频道传输系统
- Mode 3 GI=1/8
- 64QAM 3/4 I=2

Percentage of reception success [%]

Electric field strength [dBuV/m]

Number of branches:
1. 1
2. 2
3. 3
4. 4

*Official Information: NHK Science and Technology Research labs, Japan
Example: ISDB-T Vehicular Receivers

Panasonic
CN-HDS960TD
CN-HDS635TD

SANYO
NV-HD870DT
NVA-HD1500DT

Pioneer
AVIC-VH009MDG

Fujitsu ten
AVN7406HD

ALPINE
VIE-XO7B1/S1

Toyota
TDT-H56

*Official Information: NHK Science and Technology Research labs, Japan
ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB)

SFN: Single Frequency Network

- ISDB-T enables SFN
  - Addition of guard interval of OFDM
    - Robustness to multipath interference
  - Effective utilization of frequency channel

- NHK has recently developed and put into service SFN On-air (broadcast-wave) relays technology for more effective frequency utilization and equipment cost reduction
The first practical SFN in Ibaraki prefecture

*Mito, Hitachi and Yamagata Stations comprise the SFN.*

*Official Information: NHK Science and Technology Research labs, Japan*
ISDB-T System Performance in 6, 7 and 8 MHz Bandwidth

*The simulation results produced by the author at NHK Science and Technology Research labs, Japan during 1st July-31st August 2009
### Simulation Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>6 (MHz)</th>
<th>7 (MHz)</th>
<th>8 (MHz)</th>
<th>6 (MHz)</th>
<th>7 (MHz)</th>
<th>8 (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>428.571</td>
<td>500</td>
<td>571.428</td>
<td>5.572</td>
<td>6.501</td>
<td>7.430</td>
</tr>
<tr>
<td>No. of Segment</td>
<td>1</td>
<td></td>
<td></td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No of carriers</td>
<td>432</td>
<td></td>
<td></td>
<td>5617</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective Symbol Length (µs)</td>
<td>1008</td>
<td>864</td>
<td>756</td>
<td>1008</td>
<td>864</td>
<td>756</td>
</tr>
<tr>
<td>Carrier Spacing (KHz)</td>
<td>0.992</td>
<td>1.157</td>
<td>1.322</td>
<td>0.992</td>
<td>1.157</td>
<td>1.322</td>
</tr>
<tr>
<td>Guard Interval (1/8) (µs)</td>
<td>126</td>
<td>108</td>
<td>94.5</td>
<td>126</td>
<td>108</td>
<td>94.5</td>
</tr>
<tr>
<td>Modulation</td>
<td>QPSK</td>
<td></td>
<td></td>
<td>64QAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEC</td>
<td>2/3</td>
<td></td>
<td></td>
<td>3/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time interleave</td>
<td>4 (~0.4 sec)</td>
<td></td>
<td></td>
<td>2 (~0.2 sec)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit rate (Mbps)</td>
<td>0.416</td>
<td>0.485</td>
<td>0.555</td>
<td>18.252</td>
<td>21.298</td>
<td>24.341</td>
</tr>
</tbody>
</table>
Gaussian Noise and Multipath Characteristics of 6, 7, 8 MHz BW: (1 and 13 Segments)

1-Segment, QPSK, Delay = 50 us, D/U = 3 dB

13-Segment, 64QAM, Delay = 50 us, D/U = 3 dB

- ISDB-T has the same Gaussian and Multipath Characteristics in all bandwidth (6, 7 and 8 MHz) for both 1 and 13 segments. Since both carrier and noise power are directly proportional to bandwidth size.
Multipath Characteristics of 6, 7, 8 MHz BW:
(13 Segments)

- When delay time of the scattered signal exceeds the guard interval length, the performance become worse in every bandwidth regardless of the value of D/U.
- For the same D/U, system with 6 MHz bandwidth has the best performance among all, due to the longest guard interval.

**Multipath Characteristics of 13-Segment with various D/U**
Comparison of DTTB Systems
## Comparison of Digital TV systems in the World

<table>
<thead>
<tr>
<th>System Characteristics</th>
<th>Japan - Brazil (ISDB-T)</th>
<th>EU (DVB-T)</th>
<th>China (DTMB)</th>
<th>USA (ATSC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transmission System</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Robustness against noise</td>
<td><strong>Excellent</strong></td>
<td><strong>Medium</strong></td>
<td><strong>Excellent</strong></td>
<td><strong>Poor</strong></td>
</tr>
<tr>
<td>HDTV + Mobile TV with one transmitter by one Bandwidth</td>
<td>In service</td>
<td>Not available (Need additional Transmitter for Mobile TV) →Double investment</td>
<td>Not available (Need additional Transmitter for Mobile TV) →Double investment</td>
<td>Not available (Need additional Transmitter for Mobile TV) →Double investment</td>
</tr>
<tr>
<td>Emergency Warning System</td>
<td>In service</td>
<td>Not In service</td>
<td>Not In service</td>
<td>Not In service</td>
</tr>
<tr>
<td>openness</td>
<td>No limit to use</td>
<td>Need to pay royalty of Middle-ware</td>
<td>• Not international standard</td>
<td>No info</td>
</tr>
</tbody>
</table>

- **Multi-Carrier**
- **Single-Carrier**
- **Not standardized in ITU**
- Chinese has 2 standards, standard is not unified.
## 3 DTTB Systems Main Specifications Comparison

<table>
<thead>
<tr>
<th>Rec. ITU-R 1306-3</th>
<th>System A</th>
<th>System B</th>
<th>System C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td>ATSC</td>
<td>DVB-T</td>
<td>ISDB-T</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>Single carrier System</td>
<td><strong>No-segment</strong>, multi-carrier OFDM</td>
<td><strong>13 segments</strong>, multi-carrier OFDM</td>
</tr>
<tr>
<td><strong>No. of radiated carriers</strong></td>
<td>-</td>
<td>1705 (2k mode), 3409 (4k mode), 6817 (8k mode)</td>
<td>1405 (mode 1), 2809 (mode 2), 5617 (mode 3)</td>
</tr>
<tr>
<td><strong>Modulation method</strong></td>
<td>8VSB</td>
<td>QPSK, 16QAM, 64QAM, <strong>MR-16QAM, MR-64QAM</strong></td>
<td>DQPSK, QPSK, 16QAM, 64QAM</td>
</tr>
<tr>
<td><strong>Bit/Symbol</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Interleaving</strong></td>
<td>Freq. No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>No</td>
<td>No</td>
<td><strong>Yes (0, 0.1, 0.2, 0.4 s)</strong></td>
</tr>
<tr>
<td><strong>Transmission Frame Duration</strong></td>
<td>48.4 ms (6 MHz), 43.4 ms (7 MHz), 37.2 ms (8 MHz)</td>
<td>272 OFDM symbols</td>
<td>204 OFDM symbols</td>
</tr>
<tr>
<td><strong>Net Data Rate (Mbps)</strong></td>
<td>19.39 (6 MHz)</td>
<td>3.69-23.5 (6 MHz), 4.35-27.71 (7 MHz), 4.98-31.67 (8 MHz)</td>
<td>3.65-23.2 (6 MHz), 4.26-27.1 (7 MHz), 4.87-31.0 (8 MHz)</td>
</tr>
<tr>
<td><strong>Configuration Signal</strong></td>
<td>-</td>
<td>TPS</td>
<td>TMCC</td>
</tr>
<tr>
<td><strong>C/N in AWGN channel</strong></td>
<td>15.19, 9.2, 6.2 dB depending on channel code</td>
<td>3.1-20.1 (dB)</td>
<td>5.0-23.0 (dB)</td>
</tr>
</tbody>
</table>

*Official Information: ARIB STD B1 version 1.6*
Comparison between ISDB-T and DVB-T

**ISDB-T (Terrestrial)**
- **Have Band segmentation**
- 1 channel
- **Fixed reception**
  - HD TV
  - SD Multi TV
- **One Transmitter is enough**
- **Very Economical**

**DVB-T (Terrestrial)**
- **Different standard**
- 1 channel
- **Fixed reception**
  - HD TV
  - SD Multi TV
- **Transmitter for Fixed TVs**

**DVB-H (Handheld)**
- **Another 1 channel**
- **Mobile TV**
  - Portable TV handset
- **Another Transmitter For Mobile TV**

**Double- Investments!!**

**Comparison between ISDB-T and DVB-T**
Comparison between ISDB-T and DVB-T

Result of Comparison Test in Chile

→ ISDB-T is more cost effective than DVB-T because ISDB-T can cover wider service area than DVB-T at the same transmitting power.

If 10 million households can watch digital TV with indoor antenna with ISDB-T, then only 8 million households can watch digital TV with indoor antenna with DVB-T. 2 million people have to prepare outdoor antenna.)

*Official Information: Ministry of Internal Affairs and Communications, Japan
Coverage of ISDB-T is larger than that of DVB-T under same transmitter condition.

ISDB-T can cover their national land by smaller number of transmitters than DVB-T.

ISDB-T’s signals CAN be received
DVB-T’s signals CANNOT be received

Both ISDB-T’s signals and DVB-T’s signals can be received
Comparison of MR-64QAM and 64QAM

*The simulation results produced by the author at NHK Science and Technology Research labs, Japan during 1st July-31st August 2009
**Fig. 4:** Signal Constellations of various $\alpha$ values (power normalization)

ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB)
Gaussian Noise and Multipath Characteristics of MR-64QAM

- 64QAM modulation technique provides superior performance in terms of BER than MR-64QAM in both Gaussian and Multipath Characteristics.
ISDB-T: Integrated Services Digital Broadcasting - Terrestrial (Japanese DTTB)

Current Situation

Official Information: DIBEG, Ministry of Internal Affairs and Communications, NHK Science and Technology Research Labs, Japan
More than 153 millions ISDB-T receivers have been shipped.

ISDB-T receiver has largest number of shipment in the world.

Official statistics on DEC 2009: "DVB Worldwide"
**Tendency of STB price in Japan**

USD

- USD 163
- USD 45 (with CAS) made in Japan
- USD 39 (without CAS)

USD 27 (without CAS) FOB (Free-on-board)

*Official Information: DiBEG, Japan*
Global Manufacturers of ISDB-T Receivers

- Gradiente
- Philips
- Positivo
- Tec Toy
- Semp Toshiba
- Ebcom
- Samsung
- LG
- Envisio
- Aiko
- Amplimatic
- Thevear
- Visiontec
- Zinwell
- Panasonic
- Sony
- Olévia
- Telesystem
- Plasmatic
- Coship
- EWD

In Japan: Sony, Panasonic, Hitachi, Toshiba, NEC, Sanyo, Sharp Philips, Samsung, EWD, Dynaconnective, Maspro, Pixela, etc.....
Portable TV receivers in the Japanese market

Affordable portable TV receiver

Web site

Web site

Affordable portable TV receiver with Video recording function

2.479円

23.5

$23.5

5,889円

56.8

$56.8

* Average rate of last 3 years: *1USD=105.29JPY
Global Manufacturers of ISDB-T Transmitters

• TOSHIBA
  Company headquarters are in Tokyo, Japan.
  http://www3.toshiba.co.jp/snis/ovs/broadcast_top.htm

• NEC
  Company headquarters are in Tokyo, Japan.
  http://www.nec.com/global/prod/nw/broadcast/index.html

• ROHDE & SCHWARZ
  Company headquarters are in Munich, Germany.
  http://www2.rohde-schwarz.com/en/products/broadcasting/tv_transmitters/tv_transmitter_power/

• HARRIS
  Company headquarters are in Melbourne, Florida, USA

• LINEAR
  Company headquarters are in Santa Rita do Sapucai', Brazil.
# ISDB-T Receivers in Japan

<table>
<thead>
<tr>
<th>Image and Information of receivers</th>
<th>Television</th>
<th>STB</th>
<th>Portable TV receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>DY-32SDK200</td>
<td>PRD-LA103-16</td>
<td>WS-TV1310SK</td>
<td>DY-1S25</td>
</tr>
<tr>
<td>Dynaconnective Co.,Ltd</td>
<td>PIXELA CORPORATION</td>
<td>Don Quijote Co., Ltd</td>
<td>Dynaconnective</td>
</tr>
<tr>
<td>Size</td>
<td>32inches</td>
<td>16inches</td>
<td>13.3inches</td>
</tr>
<tr>
<td>Price</td>
<td>385USD</td>
<td>193USD</td>
<td>180USD</td>
</tr>
</tbody>
</table>

(*demonstrated at International ISDB-T Forum at Lima, Peru, 21st September 2009)

*Official Information: Ministry of Internal Affairs and Communications, Japan

*1USD=103.37 JPY
## Comparison of price of STB (Set Top Box)

<table>
<thead>
<tr>
<th></th>
<th>ISDB-T</th>
<th>DVB-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPEG4</td>
<td>6 MHz (South America)</td>
<td>19.99 US$</td>
</tr>
<tr>
<td>MPEG2</td>
<td>10.98 US$</td>
<td>*32 US$</td>
</tr>
</tbody>
</table>

*Presentation by DVB–T in Costa Rica on 21st January, 2010. (No Estimation)*

*Official Information: DiBEG, Japan*
Current DTTB Situation in the World

*Official Information: DiBEG, Japan
ISDB-T Countries are Expanding!!

Since 2009, all countries, that conducted deliberate comparison in technical / economical aspects between ISDB-T and DVB-T, have been adopting ISDB-T!!!
Development of ISDB-T Multi-Band STB

Demonstration of 8MHz ISDB-T System

*Official Information: NHK Science and Technology Research labs, Japan
Development of ISDB-T Multi-band STB

ISDB-T Multi-band Set top box

8 MHz Channel Spectrum

*Official Information: NHK Science and Technology Research labs, Japan
Summary of ISDB-T Transmission system

- ISDB-T promises **flexible** broadcasting services through hierarchical transmission
- ISDB-T is **robust** for interferences because of OFDM, time and frequency interleaving technology
- ISDB-T has technological **advantages in mobile reception**
- **HDTV** and **mobile service** can be transmitted **simultaneously**
  - one-segment service for handheld receivers
- **HDTV vehicular system** using diversity reception technology
  - The same HDTV broadcasted for fixed receiver can be viewed in motor vehicle
- **EWS** (Emergency Warning System)
  - Handheld receivers woken up by EWS signal alerts the user quickly of disaster (earthquake and tsunami, etc) warnings.
- **SFN** for effective frequency utilization
- Currently, **Brazil, Peru, Chile, Argentina, Venezuela, Paraguay, Ecuador Costa Rica** and **Philippines** decided to adopt ISDB-T as their DTTB system.
Thank you for your kind attention!

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http://www.tc.ait.ac.th
Nokia admits DVB-H is not succeeding

14 April 2008 20:07 by James "Dela" Delahunty | 2 comments

The world's largest mobile phone handset manufacturer Nokia has admitted that mobile television broadcasting is not catching on as previously expected. Despite the support for the DVB-H standard which is backed heavily by Nokia, only a few operators in Europe have opened any TV broadcasting services. The European Union backed the DVB-H standard last year.

"It's a bit in a turmoil," Niklas Savander, head of Nokia's Internet services, told a conference in Helsinki. Mobile phones on the market that can retrieve and playback TV programming use third-generation (3G) mobile networks, which allows the carriers to charge for data rates which ultimately can affect the overall quality of content, and the number of users.

"We have seen that there are multiple segments who are not interested in the broadcasting, but rather in downloads. Roll out is slower than also we anticipated a couple of years ago," Savander said.

DVB-H seems to have problems

Broadband TV News
The Business of Multiscreen Television

Spain abandons terrestrial mobile TV

By Robert Briel
May 19, 2010 08:17 UK

For the moment, Spain will not introduce terrestrial mobile TV, according to Bernardo Lorenzo, DG of telecommunications at the Ministry of Industry, quoted in local press reports. If there is not an increase in demand, the government will allocate the frequencies destined for mobile DTT to other services.

Industry players in the country "have not proposed an appropriate business model," he said. The country does not want to become "one of the failures that have occurred in Europe", according to Lorenzo. Also, the technological impact for the country of not introducing broadcast mobile TV "is minimal."

The announcement looks like another nail in the coffin of terrestrial mobile TV broadcasting and the DVB-H standard in particular. So far, just a few countries have commercially rolled out DVB-H services and not one has been a success. As a result, most countries now take a cautious approach.

According to the DG, terrestrial pay TV in Spain is now in the process of being accepted by the general public, "despite the apocalyptic messages that were circulating before the approval."

With regards to the introduction of terrestrial HD broadcasts, the government plans to introduce legislation requiring manufacturers to include a MPEG4/HD tuner into every TV set of 21 inches and larger.

URL: http://www.broadbandtvnews.com/2010/05/19/spain-abandons-terrestrial-mobile-tv/
Swisscom TV air to replace Swisscom TV mobile

Swisscom TV air will replace Swisscom TV mobile with immediate effect. The benefits for existing customers will be two-fold. They can now watch TV on their computers, and only have to pay CHF 9 instead of CHF 16. Following the launch of the new TV offering, Swisscom will also be discontinuing its DVB-H service for residential customers. At the moment there are not enough DVB-H compatible devices to make the service a success. The DVB-H network will remain in place for the time being.