Introduction of ISDB-T

~The latest information and technology~

29, October, 2008
CAPER
Buenos Aires, Argentina

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1. Situation of ISDB-T in Japan
Implementation Schedule of ISDB-T in Japan

1994
- MPT asked to Council for technical requirement

1998
- Issue of Digital Broadcasting Study Group Report

1999
- MPT established technical standard

1999-2003
- Real Scale Experiment Broadcasting

Apr. 2003
- Provisional licenses were awarded

Feb. 2003
- Start of Analog channel relocation

Dec. 1st 2003
- Start of ISDB-T (Tokyo, Nagoya, Osaka)

Apr. 1st 2006
- Start of 1-Segment Broadcasting

Oct. 2006
- Start of ISDB-T (main city of the whole country)

Jul. 2011
- Analog disappears
Estimation of the Number of Digital Broadcasting Receivers in Japan

From The Association for Promotion of Digital Broadcasting

- Sales Volume
- Households


Events:
- Athens Olympic Games
- FIFA World Cup Germany
- Beijing Olympic Games
- FIFA World Cup
- Stop of Analog Broadcasting

Years with Notes:
- 2003: [x 1,000]
- 2004: [x 1,000]
- 2005: [x 1,000]
- 2006: [x 1,000]
- 2007: [x 1,000]
- 2008: [x 1,000]
- 2009: [x 1,000]
- 2010: [x 1,000]
- 2011: [x 1,000]
Penetration of Fixed receivers and Mobile TV Phones

*More than 70 Millions have been sold so far.

*More than 2 Million mobile phone with one-seg have been sold every month.

Source: Japan Electronics and Information Technology association (JEITA), Japan Cable Laboratory
Cellular Phones with One-Seg
**In-car TV Receivers**

### Navigation System
- **Full-Seg/One-Seg**
  - **Strada CN-HDS965TD**
    - Panasonic
  - **AVIC-VH099G**
    - Pioneer
  - **HS706D-A**
    - NISSAN/SANYO

### Portable Navigation Device
- **One-Seg Only**
  - Mini GORILLA NV-SD10DT
    - SANYO

### In-Car TV
- **One-Seg Only**
  - GORILLA NV-HD830DT
    - SANYO

*Full-Seg is Optional*
PCs with ISDB-T tuner (One-Seg)
USB Type ISDB-T Tuners for One-Seg
Portable DVD Player with ISDB-T tuner (One-Seg)

Panasonic

TOSHIBA

TOSHIBA
Other Portable One-Seg Receivers

Portable Audio Player

Portable Electronic Dictionary

Portable Navigator

Portable TV
# Manufactures of Portable One-Seg Receivers

<table>
<thead>
<tr>
<th>Mobile Phone</th>
<th>Car Navigation</th>
<th>PC Tuner</th>
<th>Audio/DVD Player</th>
<th>TV/Radio</th>
<th>Video Game</th>
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<tbody>
<tr>
<td>Toshiba</td>
<td>Panasonic</td>
<td>Logitech</td>
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<td>Pixela</td>
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<td>Casio</td>
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</table>
2. System Requirements and Technologies of ISDB-T
The system requirement was formally approved at the meeting of Technical Communication Council in 1994.

1. System flexibility: **Segmentation, Hierarchical transmission**
2. Robustness against impulse noise and multi-path interference: **BST-OFDM, Time interleaving**
3. Mobile reception: **BST-OFDM, Time interleaving**
4. Portable reception: **BST-OFDM, Time interleaving, One seg (partial reception)**
5. Effective frequency usage: **SFN**
6. Compatibility with digital radio services: **Segmentation**
2.1 OFDM
OFDM Signals

OFDM was presented by Mr. Hirosaki (NEC) for the first in the world.

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 Spectrum

\[
F_s = 1/T_s
\]
Superiority of OFDM

BER vs. Eb/NO

- QPSK
- OFDM
- No Ghost

Multipath Profile (dB)

Delay (μs)

D/U
2.2 Segmentation
System for Mobile and Portable Reception
~Segmentation~

Television Broadcast (ISDB-T)

Audio Program
Hi-Vision Program

Simple TV (Mobile)
Standard TV (Mobile)
Standard TV (Home)

OFDF Segment

5.6MHz

Partial Receive

Terrestrial Digital Television Receiver

Audio Broadcast (ISDB-Tsb)

Audio Program
Audio Program
Data, etc

430kHz
1.29MHz

One-seg & Terrestrial Digital Audio Receiver
Services of ISDB-T

- Support 3 reception types by one channel
- ISDB-T can also use internet

- 6MHz
- 13 Segments

- Fixed Reception
- 12 or 13 segments

- Mobile/Handheld Reception
- 13 or 12 + 1 segments

- Home Receiver

- Communication / Internet

- Communication carrier

- Handheld terminal

- Receiver in Vehicle

- HDTV

- TV station

- Diversity reception
Merits of Digital Broadcasting

Easy to add new services

Data Broadcasting

Weather forecast

News

Interactive TV, e.g. interactive shopping

Information linked to on-air program

You can see the products and you can buy them directly.
## Transmission Parameters

<table>
<thead>
<tr>
<th>Mode</th>
<th>Mode 1 (Mobile)</th>
<th>Mode 2 (Mobile, Fixed)</th>
<th>Mode 3 (Fixed)</th>
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<tbody>
<tr>
<td>Number of carrier</td>
<td>1405</td>
<td>2809</td>
<td>4992</td>
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<tr>
<td>Carrier distance</td>
<td>3.968kHz</td>
<td>1.984kHz</td>
<td>0.992kHz</td>
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<tr>
<td>Valid symbol length</td>
<td>0.252ms</td>
<td>0.504ms</td>
<td>1.008ms</td>
</tr>
<tr>
<td>Guard interval length</td>
<td>1/4, 1/8, 1/16, 1/32 of valid symbol length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error correction</td>
<td>inner coding</td>
<td>Convolution coding (1/2, 2/3, 3/4, 5/6, 7/8)</td>
<td>Reed-Solomon (208, 188)</td>
</tr>
<tr>
<td>outer coding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time domain interleave</td>
<td></td>
<td>Convolution 0, 0.1, 0.2, 0.4 second</td>
<td></td>
</tr>
<tr>
<td>BST-OFDM Segment</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Hierarchical transmission</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Bit rate</td>
<td></td>
<td>3.65 – 23.23 Mbps</td>
<td></td>
</tr>
</tbody>
</table>
2.3 Hierarchical Transmission
Information Bit-rate v.s. C/N

Guard interval: 1/8

- QPSK
- DQPSK
- 16 QAM
- 64 QAM

Information bit rate (Mbit/s) vs. C/N (dB)

- 6dB
- 17.5dB

- 1/2
- 2/3
- 3/4
- 5/6
- 7/8
2.4 Time Interleaving and Mobile Reception
Impulse Noise to Analog TV
Comparative Test in Peru
Test against Impulse Noises from Hair Dryer
Effect of Time Interleaving (1)

![Graph showing BER vs C/N for different fd values with and without time interleaving.]

- Without time interleaving
- With time interleaving

- fd = 7 Hz
- fd = 20 Hz
- fd = 70 Hz
Why Mobile and Portable Reception

(1) All kind of TV programs including data services can be received at home in the future, via satellite, cable, internet, etc..

(2) People’s outside life times are increasing in the present-day life.

(3) Broadcasters have to serve anytime for such people including video, audio, and data.

(4) Especially, the emergency information services are very important for people.

(5) VHF and UHF band frequencies used by broadcasters, are the best for mobile and portable reception.

(6) In the age of the convergence of broadcasting and communication, Broadcasters can’t survive without mobile and portable services.
Field Trials of Mobile Reception TV for the First Time in the World (1993)
Comparison between Digital (OFDM) and Analog Broadcasting
Effect of Time Interleaving (2)

Result of field trials

Mode 2, DQPSK, 1/2, 13 seg.

Correct Reception Time Rates (%)

With Time Interleaving
Without Time Interleaving

Measured Field Strength (dBμ V/m)

35 40 45 50 55 60 65

99%
2.5 SFN(Single Frequency Network)
Reception in SFN

**CLI Cancellation**

- Subscriber
- SFN relay station
- Main station
- CLI: Coupling Loop Interference
- Desired signal
- Reflected signal
- Sea, Lake
- SFN relay station
- SFN stations outside the dedicated area

**Diversity reception**

- Main station
- Desired signal
- Large delay signal
- Reflected signal
- Sea, Lake

**Large delay multi-path equalization**

- Subscriber
- SFN relay station
- Subscriber

By NHK
Extended Equalization Range

Without equalizer

Equalizing range of delay

With equalizer

Delay of multipath (μs)

BER

D/U=6dB
C/N=30dB

GI
Tu/8

10^0

10^-2

10^-3

10^-4

0 100 200 300 400 500 600 700 800 900 1000
3. Conclusion
(1) The Japanese terrestrial digital broadcasting (ISDB-T) had been developed based on a series of experiences in developing TELETEXT and FM multiplex broadcasting systems.

(2) ISDB-T has a lot of merits, system flexibility, mobile and portable reception, SFN, robustness against any interferences etc. which other systems don’t have.

(3) In Japan, ISDB-T receivers have been penetrating fastest in the world, and the price is going down rapidly.

(4) Brazil decided to adopt ISDB-T as their national system in 2006 on the results of comparison of three systems, and started it in 2007.

(5) Only ISDB-T can satisfy the need of all people, and contribute to the improvement of the life of all people.

**ISDB-T is the best.**
Once Again

Since the radio frequencies are the common resources for people, we have to use them usefully.

The most effective usage for VHF and UHF is for not fixed but mobile and portable broadcasting.

Once we have decided the DTTB system as a national broadcasting standard, we can’t change them anymore. Other two groups have been continuing to improve their performances.

We should select the best system for descendants not to regret and not to accused of it later.

Broadcasters are facing on the important time if the services can be extended.

We want you in Argentina to use ISDB-T not for us but for you. If you select ISDB-T, we, the Japanese side will do our best for Argentina.
Let’s work together towards the future!