Presentation 6

"ISDB-T Receiver"

9th - 10th December 2008
Manila, Philippines
DiBEG JAPAN
Hirohiko SAKASHITA
(Panasonic Corporation)
Contents

- Reception types of ISDB-T
- Introduction of some Japanese ISDB-T receivers
  • Fixed receivers
  • In-car receivers
  • Portable receivers
- Shipments and diffusion prediction of ISDB-T receivers
- Merits of One-Seg
- Configuration of a basic receiver
- Improvement of reception performance
  • Introduction of diversity system
  • Experiments of One-Seg diversity reception
- Trends in Price of Japanese ISDB-T receivers
Reception Types of ISDB-T in Japan

One channel of ISDB-T is divided into 13 segments. One segment of them is used for mobile and handheld TVs.

- **Fixed reception**
  - TV set, STB, Recorder
  - HDTV

- **Portable reception**
  - Cell Phone, Laptop PC, etc.
  - LDTV

- **Mobile reception**
  - Navigation System, In-car TV

- **Broadcasters**
  - 13 Segments
  - 1 Segment (One-Seg)
  - 13 Segments (Full-Seg)

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### Fixed Receivers

#### PDP TV

- **VIERA TH-42PZ800** Panasonic
- **Wooo P42-HR02** HITACHI
- **KRP-500A** Pioneer

#### LCD TV

- **REGZA 42H7000** TOSHIBA
- **AQUOS LC-42XJ1-B** SHARP
- **VIERA TH-20LX80** Panasonic
- **BRAVIA KDL-40X1** SONY
- **LCD-32FX300 (K)** SANYO
- **AQUOS LC-16E1** SHARP

#### SDTV

- **VIERA TH-15LD70** Panasonic
- **AQUOS LC-13SX7** SHARP

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Fixed Receivers (Cont.)

HDD/DVD Recorder

<table>
<thead>
<tr>
<th>Model</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDZ-D800</td>
<td>SONY</td>
</tr>
<tr>
<td>VARDIA RD-X8</td>
<td>TOSHIBA</td>
</tr>
<tr>
<td>DIGA DMR-XW120</td>
<td>Panasonic</td>
</tr>
<tr>
<td>DVR-DW200</td>
<td>MITSUBISHI</td>
</tr>
</tbody>
</table>

Blu-ray

<table>
<thead>
<tr>
<th>Model</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDZ-X100</td>
<td>SONY</td>
</tr>
<tr>
<td>DIGA DMR-BW930</td>
<td>Panasonic</td>
</tr>
</tbody>
</table>

STB

<table>
<thead>
<tr>
<th>Model</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>TU-MHD600</td>
<td>Panasonic</td>
</tr>
<tr>
<td>DT400</td>
<td>MASPRO</td>
</tr>
</tbody>
</table>

Cable STB

<table>
<thead>
<tr>
<th>Model</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>TZ-DCH1820</td>
<td>Panasonic</td>
</tr>
</tbody>
</table>

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### Fixed Receivers (Cont.)

#### Desktop PC

<table>
<thead>
<tr>
<th>Model</th>
<th>Screen Size</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALUESTAR W VW790/RG</td>
<td>22 inch</td>
<td>1680x1050</td>
</tr>
<tr>
<td>NEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FMV-DESKPOWER LX70W/D</td>
<td>22 inch</td>
<td>1680x1050</td>
</tr>
<tr>
<td>FUJITSU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prius One type W AW37W5U</td>
<td>20.1 inch</td>
<td>1680x1050</td>
</tr>
<tr>
<td>HITACHI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Notebook PC (medium-large size)

<table>
<thead>
<tr>
<th>Model</th>
<th>Screen Size</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>LaVie L LL970/HG</td>
<td>15.4 inch</td>
<td>1280x800</td>
</tr>
<tr>
<td>NEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FMV-BIBLO NX95W/D</td>
<td>17 inch</td>
<td>1440x900</td>
</tr>
<tr>
<td>FUJITSU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qosmio G40/95C</td>
<td>17 inch</td>
<td>1920x1200</td>
</tr>
<tr>
<td>TOSHIBA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**In-car Receivers**

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

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

### In-Car TV
**One-Seg Only**
- **GORILLA NV-HD830DT**
  SANYO
- **CAV-TD85D1**
  SANYO

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**Portable Navigation Device**

**One-Seg Only**

- **Mini GORILLA NV-SD10DT**
  SANYO

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**Full-Seg is Optional**

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■ Portable Receivers

Cell Phone  One-Seg Only

**au**
- W63SA
- W64T

**NTT DoCoMo**
- P906i
- SO906i

**Softbank**
- 923SH
- 824T

<table>
<thead>
<tr>
<th>Company</th>
<th>Models Available</th>
<th>Available Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>au</td>
<td>23</td>
<td>at the end of Sept, 2008</td>
</tr>
<tr>
<td>NTT DoCoMo</td>
<td>31</td>
<td>at the end of Sept, 2008</td>
</tr>
<tr>
<td>Softbank</td>
<td>12</td>
<td>at the end of Sept, 2008</td>
</tr>
</tbody>
</table>
Portable Receivers (Cont.)

One-Seg Only

- **DVD Player**
  - DVD-LX87 Panasonic
  - DVD-HP700ND SANYO

- **Laptop**
  - VAIO type T SONY

- **Adapters (USB, etc.)**
  - Many products are on sale.
    - BUFFALO, I・O DATA, etc.

- **Audio Player**
  - gigabeat V30E TOSHIBA

- **Dictionary**
  - Papyrus PW-TC900 SHARP

- **Portable TV**
  - XDV-100 SONY
Shipment Volume of ISDB-T Receivers

<table>
<thead>
<tr>
<th>Type</th>
<th>Units (thousand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>1,196</td>
</tr>
<tr>
<td>Cable STB</td>
<td>5,872</td>
</tr>
<tr>
<td>STB</td>
<td>520</td>
</tr>
<tr>
<td>Recorder</td>
<td>6,851</td>
</tr>
<tr>
<td>LCD TV</td>
<td>20,453</td>
</tr>
<tr>
<td>PDP TV</td>
<td>3,194</td>
</tr>
<tr>
<td>CRT TV</td>
<td>722</td>
</tr>
</tbody>
</table>

Total until August, 2008: 38,808 thousand units

※Receivers only for One-Seg and in-car receivers are not included.

Source: Japan Electronics and Information Technology Association (JEITA)
Shipments Volume of Cell-phone w. One-seg Rcv.

Source: Japan Electronics and Information Technology Association (JEITA)
Diffusion Prediction of ISDB-T Receivers

The cumulative total of sales until 2011 will be 117 million units.

※Receivers only for One-Seg and in-car receivers are not included.

Source: Japan Electronics and Information Technology Association (JEITA)
Diffusion Prediction of One-Seg Cell Phones

A certain research institute has reported diffusion prediction of One-Seg cell phones. About 30% of cell phone users will have One-Seg cell phones in 2010.

Source: Yano Research Institute Ltd., Japan
Merits of One-Seg

- High quality video & audio in a mobile environment
  - Robustness to noise and multipath

Stable reception in a mobile environment

- Easy to put the function on portable terminals
  - One-seg receivers need lower cost, smaller devices, lower power consumption, and lower CPU power than Full-seg receivers.

Various portable terminals get possible to have TV function.
## Tuner Modules for One-Seg

<table>
<thead>
<tr>
<th>Maker</th>
<th>ALPS</th>
<th>ALPS</th>
<th>MURATA</th>
<th>SHARP</th>
<th>MITSUMI</th>
<th>Panasonic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model/Type</td>
<td>TDPJ</td>
<td>TSL</td>
<td>SUMUDDJ-LS101</td>
<td>VA35JZ9910</td>
<td>DVT7-J11D</td>
<td>CTMW02</td>
</tr>
<tr>
<td>Feature</td>
<td>Small size</td>
<td></td>
<td>High durability for automobile environments</td>
<td>Small size</td>
<td>Low power consumption</td>
<td>Small size</td>
</tr>
<tr>
<td>Size(mm)</td>
<td>9.5x9.5x1.7</td>
<td>25.0x15.2x2.1</td>
<td>8.7x9.6x1.5</td>
<td>9.0x9.0x1.5</td>
<td>8.9x8.9x1.5</td>
<td>12.5x16.5x1.95</td>
</tr>
<tr>
<td>Power consumption (mW)</td>
<td>180</td>
<td>-</td>
<td>-</td>
<td>95</td>
<td>140</td>
<td>100(low power mode) /115(normal mode) ※single mode</td>
</tr>
<tr>
<td>Minimum input sensitivity (dBm,1segment bandwidth, QPSK1/2)</td>
<td>-109</td>
<td>-107.5</td>
<td>-110</td>
<td>-109</td>
<td>-109</td>
<td>-109(single mode) /-112(diversity mode)</td>
</tr>
</tbody>
</table>

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## Improvement of One-Seg Cell Phones

<table>
<thead>
<tr>
<th>Model</th>
<th>P901iTV</th>
<th>P903iTV</th>
<th>P906i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Released date</td>
<td>Mar. 2006</td>
<td>Feb. 2007</td>
<td>June 2008</td>
</tr>
<tr>
<td>Size(mm) (when closed)</td>
<td>110x51x27</td>
<td>110x50x22</td>
<td>108x50x17.4</td>
</tr>
<tr>
<td>Weight(g) (with battery)</td>
<td>150</td>
<td>139</td>
<td>123</td>
</tr>
<tr>
<td>Display</td>
<td>2.5inch QVGA (240x320)</td>
<td>2.8inch Wide QVGA (240x400)</td>
<td>3.1inch Wide VGA (480x854)</td>
</tr>
<tr>
<td>International Roaming</td>
<td>3G</td>
<td>3G</td>
<td>3G / GSM</td>
</tr>
<tr>
<td>Continues Call time(min)</td>
<td>145</td>
<td>195</td>
<td>200</td>
</tr>
<tr>
<td>Continuous watch time for “One-Seg”</td>
<td>3 h</td>
<td>7h</td>
<td>6 h</td>
</tr>
</tbody>
</table>

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Between a Full-Seg receiver and a One-Seg receiver, the basic configurations are about the same, though there are some differences such as a tuner, video decoder, resolution of display and so on.
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**Functional Block Diagram of the Front-end**

- RF Signal
- Down Conversion
- IF Signal
- A/D Conversion
- FFT
- Channel Estimation and Equalization
- Frequency De-interleave
- Time De-interleave
- Demapping
- Bit De-interleave
- Reed-Solomon Decoding
- Viterbi Decoding
- Byte De-interleave
- Energy Dispersal
- Reed-Solomon Decoding

FFT : Fast Fourier Transform
TMCC : Transmission and Multiplexing Configuration Control
Functional Block Diagram of the Back-end

- PID filter
- Section filter
- PSI/SI processing
- DSM-CC Data carousel processing
- Application Execution Engine (MHP/ARIB-J)
- Presentation Engine (BML Browser)
- Blending
- TS
- PID filter
- PES processing
- Caption Decoder
- Video Decoder
- Scaling
- Audio Decoder

Definitions:
- PID: Packet Identifier
- PES: Packetized Elementary Stream
- PCR: Program Clock Reference
- PSI/SI: Program Specific Information/Service Information
- DSM-CC: Digital Storage Media - Command and Control
- BML: Broadcast Markup Language

※Not currently operated in Japan
Basic Applications on ISDB-T Receivers

- Frequency scanning / Channel list
- Channel selecting
- Audio/Video playing back
- EPG (Electronic Program Guide)
- Closed Caption / Subtitle
- Data Broadcasting (BML)
- Interactive service

etc.
ISDB-T, the Digital Television
for the Philippines

■ Mobile Reception Environment

1. Lower electric field strength because of low antenna height (Approx. 10dB down)
2. Smaller antenna gain because of a nondirectional antenna (Approx. 10dB down)
3. Greatly affected by multipath fading because of mobile reception
4. Doppler shift because of high-speed movement
Improvement of Reception Performance

Improvement of a reception sensitivity with a single antenna almost reaches the limit.

Diversity reception techniques are expected to improve total reception sensitivity.

In fixed reception, diversity effect is 3dB at maximum. But in mobile reception, e.g. in-car TVs or cell phone TVs in a car or train, the effect reaches 6 - 8 dB.
Overview of Diversity System

Ripples are generated because of multipath reception.

Direct wave

Reflected wave (Multipath)

RF Tuner → FFT

Channel Estimation and Equalization

Selecting or Combining

Demapping
2-Diversity System (4 Antennas and 2 Tuners)

Less complex than 4-tuner diversity system.

Higher-sensitive than conventional 2 antenna-diversity system.
4-Diversity System (4 Antennas and 4 Tuners)

4-diversity system improves the reception performance more than conventional 2-diversity system, though the process becomes more complex.
Experiments of One-Seg Diversity Reception

Experiment 1: Field test
A) The upper terminal is using single antenna reception system.
B) The middle terminal is using diversity reception system of SANYO.
C) The lower terminal is using diversity reception system of a certain company.
Experiments of One-Seg Diversity Reception

Experiment 2: Laboratory test
A) The left terminal is using diversity reception system of SANYO.
B) The right terminal is using diversity reception system of a certain company.
Diversity Reception System for Cell Phones

Diversity systems are applicable to cell phones as well as in-car receivers. Now, only one product, P903iTV, is equipped with diversity system. It has two antennas for One-Seg, a whip antenna and an internal antenna.
Launched digital terrestrial television

- LCD 37-inch: $6,203
- PDP 42-inch: $5,743
- CRT 32-inch: $1,565
- LCD 37-inch: $1,113

<table>
<thead>
<tr>
<th>Month</th>
<th>LCD 37-inch</th>
<th>PDP 42-inch</th>
<th>CRT 32-inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 2003</td>
<td>$6,203</td>
<td>$5,743</td>
<td>$1,565</td>
</tr>
<tr>
<td>Mar. 2004</td>
<td>$5,743</td>
<td>$1,113</td>
<td></td>
</tr>
<tr>
<td>Sep. 2005</td>
<td>$1,565</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar. 2006</td>
<td>$1,113</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep. 2007</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Distribution of LCD Price

Price (U.S.$)

Prices are going down!
## Varied LCD Digital Receivers

<table>
<thead>
<tr>
<th>PHOTO</th>
<th>TYPE</th>
<th>PRICE</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="ORION LD15V-TD1" /></td>
<td>ORION</td>
<td>44,850 JPY (≒ 388 U.S.$)</td>
<td><a href="http://www.orion-electric.co.jp/jp/products/index.html">http://www.orion-electric.co.jp/jp/products/index.html</a></td>
</tr>
<tr>
<td><img src="#" alt="SHARP LC-46GX2W" /></td>
<td>SHARP</td>
<td>225,800 JPY (≒ 1,953 U.S.$)</td>
<td><a href="http://www.sharp.co.jp/aquos/lineup/gx2/index.html">http://www.sharp.co.jp/aquos/lineup/gx2/index.html</a></td>
</tr>
</tbody>
</table>
ISDB-T, the Digital Television for the Philippines

**Distribution of PDP Price**

Price (U.S.$)

- Prices are going down!

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## Varied PDP Digital Receivers

<table>
<thead>
<tr>
<th>PHOTO</th>
<th>TYPE</th>
<th>PRICE</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="HITACHI P37-H01 (37-inch)" /></td>
<td>HITACHI P37-H01 (37-inch)</td>
<td>123,900 JPY (≒1,072 U.S.$)</td>
<td><a href="http://av.hitachi.co.jp/tv/plasma/01/index.html">http://av.hitachi.co.jp/tv/plasma/01/index.html</a></td>
</tr>
<tr>
<td><img src="image" alt="bydsign PH-5000DFK (50-inch)" /></td>
<td>bydsign PH-5000DFK (50-inch)</td>
<td>239,800 JPY (≒2,074 U.S.$)</td>
<td><a href="http://www.bydsign.jp/Form/Product/ProductDetail.aspx?shop=0&amp;cat=101&amp;swrd=&amp;pid=PH-5000DFK&amp;vid=">http://www.bydsign.jp/Form/Product/ProductDetail.aspx?shop=0&amp;cat=101&amp;swrd=&amp;pid=PH-5000DFK&amp;vid=</a></td>
</tr>
</tbody>
</table>
## High-Performance Set Top Box

<table>
<thead>
<tr>
<th>PHOTO</th>
<th>TYPE</th>
<th>PRICE</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="SONY VGF-DT1" /></td>
<td>SONY VGF-DT1</td>
<td>42,987 JPY (≒372 U.S.$)</td>
<td><a href="http://www.ecat.sony.co.jp/vaio/acc/acc.cfm?PD=26654">http://www.ecat.sony.co.jp/vaio/acc/acc.cfm?PD=26654</a></td>
</tr>
<tr>
<td><img src="image" alt="MASPRO DT400" /></td>
<td>MASPRO DT400</td>
<td>27,842 JPY (≒241 U.S.$)</td>
<td><a href="http://www.maspro.co.jp/new_prod/dt400/dt400.html">http://www.maspro.co.jp/new_prod/dt400/dt400.html</a></td>
</tr>
</tbody>
</table>

These products also correspond to BS and CS digital broadcasting services.
### Low-Price Set Top Box

<table>
<thead>
<tr>
<th>PHOTO</th>
<th>TYPE</th>
<th>PRICE</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="https://via.placeholder.com/150" alt="AVOX YDIT-10" /></td>
<td>AVOX YDIT-10</td>
<td>15,213 JPY (≒132 U.S.$ )</td>
<td><a href="http://www.c-mex.co.jp/tuner.html">http://www.c-mex.co.jp/tuner.html</a></td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="YAGI DTC10" /></td>
<td>YAGI DTC10</td>
<td>16,097 JPY (≒139 U.S.$ )</td>
<td><a href="http://www.yagi-antenna.co.jp/products/home/tuner/index.html">http://www.yagi-antenna.co.jp/products/home/tuner/index.html</a></td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="MASPRO DT610" /></td>
<td>MASPRO DT610</td>
<td>17,444 JPY (≒151 U.S.$ )</td>
<td><a href="http://www.maspro.co.jp/products/dt610/tokutyo.html">http://www.maspro.co.jp/products/dt610/tokutyo.html</a></td>
</tr>
</tbody>
</table>
About 35 million analog TVs will be persisted in Japan by 2011, when transition of analog to digital broadcasting will be completed, especially in the field of public institution (e.g. schools, hospitals, and nursing homes etc.).
Conclusions

✓ Since 2003 various ISDB-T products, fixed, in-car and portable receivers have been launched in Japan.

✓ Consumer adoption of ISDB-T receiver is growing at a rapid pace for 2011 when analogue TV broadcasting will end in Japan.

✓ About 30% of cell phone users will have One-Seg cell phones in 2010 in Japan.

✓ For mobile reception, diversity techniques are very effective to improve the reception performance.
Thank you for your attention.

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