Presentation 2

Technical Aspect of ISDB-T system and Hardware

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Yasuo Takahashi

Director of DiBEG Seminar working Group (Toshiba)
Contents

• What’s ISDB-T?
  - ISDB-T is , - Requirements/Solutions, - ISDB family, - Technical solutions,
  - Parameters of ISDB-T system

• Why ISDB-T now?
  - comparison of 3 DTTV systems, - Results of comparison test in Brazil, -
    DTTV selection guide, - Conclusion

• How ISDB-T developed?
  - Pilot test in Japan, - Development of mobile receiving technology, - Proto
    type of Digital Audio/one segment receiver

• ISDB-T now in Japan (Commercial type receiver)
What’s ISDB-T?

- ISDB-T is
- Requirements/Solutions
- ISDB family
- Technical solutions
- Parameters of ISDB-T system
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 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.
Market Requirements for ISDB-T

• HDTV and Multi SDTV
• Multimedia Service
• Mobility and Portability
• Flexible/Versatile
• Data Broadcasting
• Effective Spectrum Utilization
• Commonality of Receiver
Layered Structure for Digital Broadcasting

Application Layer
- Commonality
- Interoperability
- MPEG-2 Standard

Transmission Layer
- Optimized for each transmission system
- Satellite/Terrestrial/Cable

Video
Audio
Data

Encode
Encode
Encode

Multiplex

FEC/Interleaving

Modulation

MPEG-2
ISDB Family

- Satellite (ISDB-S): Error correction RS(204,188) → Modulation TC-8PSK
- Cable (ISDB-S): Error correction RS(204,188) → Modulation 64QM
- Terrestrial (ISDB-T): Error correction RS(204,188) + Conv. code → Modulation Segmented OFDM

MPEG-2 TS

- Video
- Audio
- Data

MPEG-2

Multiplexing

Coding

Error correction RS(204,188)

Error correction RS(204,188)

Error correction RS(204,188) + Conv. code

Segmented OFDM

Modulation

Package, communication and Other media (DVB and ATSC)
Technical Solution for transmission layer of DTTV - ISDB-T

- OFDM
  - Robustness, SFN (Single Frequency Network)
- Segmented Structure
  - Extensible, Partial Reception
- Time Interleaving
  - Mobile Reception, Indoor Reception
- TMCC (Transmission and Multiplexing Configuration Control)
  - Flexible, Versatile
Transmission Scheme

- Band Segmented Transmission OFDM
  - Bandwidth of an OFDM-Segment:
    - 6/14MHz (428.6kHz) or 8/14MHz (571.4kHz)
  - Number of OFDM Segments: 13
Segmented Structure and Partial Reception

6MHz or 8MHz
Transmission Scheme

- Band Segmented Transmission OFDM
  - Bandwidth of an OFDM-Segment:
    - 6/14MHz (428.6kHz) or 8/14MHz (571.4kHz)
  - Number of OFDM Segments: 13

- Partial Reception
  - One-segment ISDB-T receiver can receive a centered segment of ISDB-T signal.
Segmented Structure and Partial Reception
Transmission Scheme

- **Band Segmented Transmission OFDM**
  - Bandwidth of an OFDM-Segment:
    - 6/14MHz (428.6kHz) or 8/14MHz (571.4kHz)
  - Number of OFDM Segments: 13

- **Partial Reception**
  - One-segment ISDB-T receiver can receive a centered segment of ISDB-T signal.

- **Hierarchical Transmission**
  - Three layers
    - Modulation, Coding rates, Length of Time interleaving
Segmented Structure and Partial Reception

An Example of Hierarchical Multiplexing

Parameter | 64QAM 3/4 | 12 segments | 16QAM 1/2 | 1 segment | Bit rate | 16.9 Mbps | 630 kbps
### Three Mode of ISDB-T

<table>
<thead>
<tr>
<th></th>
<th>Mode1 (2K)</th>
<th>Mode2 (4K)</th>
<th>Mode3 (8K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DQPSK</td>
<td>Mobile SDTV</td>
<td>Mobile &amp; Fixed</td>
<td>Fixed</td>
</tr>
<tr>
<td>QPSK</td>
<td>Mobile SDTV</td>
<td>HDTV/SDTV</td>
<td>HDTV/SDTV</td>
</tr>
<tr>
<td>16QAM</td>
<td></td>
<td>Fixed</td>
<td></td>
</tr>
<tr>
<td>64QAM</td>
<td></td>
<td></td>
<td>Fixed</td>
</tr>
</tbody>
</table>

TMCC can change the mode any time to any combination.
## Parameters of ISDB-T

(6MHz Bandwidth)

<table>
<thead>
<tr>
<th>ISDB-T Mode</th>
<th>Mode 1</th>
<th>Mode 2</th>
<th>Mode 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of OFDM Segment</td>
<td></td>
<td></td>
<td>13</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>5617</td>
</tr>
<tr>
<td>Modulation</td>
<td></td>
<td>DQPSK, QPSK, 16QAM, 64QAM</td>
<td></td>
</tr>
<tr>
<td>Active Symbol Duration</td>
<td>252 µsec</td>
<td>504 µsec</td>
<td>1,008 µsec</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>No. of Symbols per Frame</td>
<td></td>
<td></td>
<td>204</td>
</tr>
<tr>
<td>Time Interleaving</td>
<td></td>
<td></td>
<td>0, 0.125, 0.25, 0.5sec</td>
</tr>
<tr>
<td>Inner Coding</td>
<td></td>
<td>Convolutional Code (1/2, 2/3, 3/4, 5/6, 7/8)</td>
<td></td>
</tr>
<tr>
<td>Outer Coding</td>
<td></td>
<td></td>
<td>RS(204, 188)</td>
</tr>
<tr>
<td>Useful Bit Rate</td>
<td></td>
<td></td>
<td>3.65Mbps ← 23.23Mbps</td>
</tr>
<tr>
<td>Hierarchical Transmission</td>
<td></td>
<td></td>
<td>up to Three Layers</td>
</tr>
</tbody>
</table>
# Parameters of ISDB-T

(8MHz Bandwidth)

<table>
<thead>
<tr>
<th>ISDB-T Mode</th>
<th>Mode 1</th>
<th>Mode 2</th>
<th>Mode 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of OFDM Segment</td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Useful Bandwidth</td>
<td>7.434MHz</td>
<td>7.431MHz</td>
<td>7.430MHz</td>
</tr>
<tr>
<td>Carrier Spacing</td>
<td>5.291kHz</td>
<td>2.645kHz</td>
<td>1.322kHz</td>
</tr>
<tr>
<td>Total Carriers</td>
<td>1405</td>
<td>2809</td>
<td>5617</td>
</tr>
<tr>
<td>Modulation</td>
<td></td>
<td></td>
<td>DQPSK, QPSK, 16QAM, 64QAM</td>
</tr>
<tr>
<td>Active Symbol Duration</td>
<td>189 ÷ sec</td>
<td>378 ÷ sec</td>
<td>756 ÷ sec</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>No. of Symbols per Frame</td>
<td></td>
<td>204</td>
<td></td>
</tr>
<tr>
<td>Time Interleaving</td>
<td></td>
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<td></td>
</tr>
<tr>
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<td></td>
<td>Convolutional Code (1/2, 2/3, 3/4, 5/6, 7/8)</td>
<td></td>
</tr>
<tr>
<td>Outer Coding</td>
<td></td>
<td>RS(204, 188)</td>
<td></td>
</tr>
<tr>
<td>Useful Bit Rate</td>
<td>4.87Mbps ~ 30.98Mbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hierarchical Transmission</td>
<td></td>
<td>up to Three Layers</td>
<td></td>
</tr>
</tbody>
</table>
DTTV System Selection Guideline

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>Resistivity against multi-path distortion</td>
<td>DVB-T, ISDB-T</td>
</tr>
<tr>
<td>Resistivity 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>
<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>
Why ISDB-T now?

- comparison of 3 DTTV systems
- Results of comparison test in Brazil
- DTTV selection guide
- Conclusion
## 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</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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>Portable reception with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cellular phone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet access</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ethernet and Phone connector of ISDB-T TV SET
## 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>Dase-1</td>
<td>(DVB HTML)</td>
<td>BML (XHTML), ECMAScript</td>
</tr>
<tr>
<td></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>Outer (207,187) Reed-Solomon code</td>
<td>(204,188) Reed-Solomon code</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inner 2/3Trellis Code</td>
<td></td>
<td>Conv.code(1/2-7/8)</td>
</tr>
</tbody>
</table>
### Technical Details of DTTV Systems - 2

<table>
<thead>
<tr>
<th></th>
<th>ATSC</th>
<th>DVB-T</th>
<th>ISDB-T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Modulation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit/Symbol</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Frequency</td>
<td>-</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>time</td>
<td>-</td>
<td>-</td>
<td>0.1s, 0.2s, 0.4s, 0.8s</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>Information bit rate</td>
<td>19.39 Mbps</td>
<td>3.69 - 23.5 Mbps</td>
<td>3.65 - 23.2 Mbps</td>
</tr>
<tr>
<td>Channel bandwidth</td>
<td>6/7/8 MHz</td>
<td>6/7/8 MHz</td>
<td>6/7/8 MHz</td>
</tr>
</tbody>
</table>
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.
DTV Trials in the World

• Singapore, mda – 1999
  – The Panel concluded that the DVB and ISDB-T systems will work for this application. (5. Mobile TV, p.4)
  – ISDB commercial applications is not available... (in 1999)

• Hong Kong, OFTA, ATV, TVB – 1999
  – Mobile reception of ISDB-T and DVB-T was good in open areas. (5. Support of Mobile reception, p.4)

• Brazil, ABERT/SET, ANATEL – 1999/2000
  – If you look into our test report, the best performance, by far, is the ISDB-T COFDM proposal. The biggest problem is the fact that Japan is schedule to start the terrestrial transmission only in 2003.
  – Why we are choosing COFDM for Brasil, HDTV news Sunday April 9 2000 (Fernando Bittencourt: Chairman ABERT/SET group)
Result of comparison test conducted by ABERT/SET of Brazil

Original published by ABERT/SET in Portuguese. Translated and revised by NHK
## Laboratory Tests Basic Configurations

<table>
<thead>
<tr>
<th>PAYLOAD (Mbps)</th>
<th>ATSC</th>
<th>DVB-2K</th>
<th>DVB-8K</th>
<th>ISDB-4K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configurations</td>
<td>1</td>
<td>Many</td>
<td>Lots</td>
<td></td>
</tr>
</tbody>
</table>

* 2K, FEC ¾, GI 1/16 (18,67us)
** 8K, FEC 2/3, GI 1/32 (37,33us)
*** 4K, FEC ¾, GI 1/16 (31,5us), 0,1s Time Interleaving

Original published by ABERT/SET in Portuguese. Translated and revised by NHK
Laboratory Tests - Results

- Multi-path

![Graph](image)

- DVB 8K Best Result
- OFDM results are function of FEC and Receiver implementation

Original published by ABERT/SET in Portuguese. Translated and revised by NHK
**Laboratory Tests - Results**

- **Impulse Noise**

![Graph: Interference to carrier ratio as a function of the noise pulse width](image)

- **ISDB – Best Results (Time Interleaving)**
- **DVB 8K Better than DVB 2K (5dB)**

*Original published by ABERT/SET in Portuguese. Translated and revised by NHK*
Laboratory Tests - Results

◆ Mobile Reception Simulation

ATSC did not work at 1.8 Km/h
Number of carriers is a key factor
ISDB 4K has similar performance to the DVB 2K
DVB 8K only portable Rx.

Original published by ABERT/SET in Portuguese. Translated and revised by NHK
Field Test – Results Coverage

Successful Reception Percentage -
Cumulative function - Criteria: Margin - F(50,90) > 0 and Errors < 5

- DVB 8k similar to ISDB 4k
- ATSC similar to DVB 2k (inadequate)
- ISDB 4k Higher Payload (+1.2 Mbps)

Original published by ABERT/SET in Portuguese. Translated and revised by NHK

UK used DVB-2K at first
(Added by NHK)
Any improvement of digital receiver was not considered to make the table below.

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</tr>
<tr>
<td>System commonality with digital terrestrial sound broadcasting (One segment receiver is available)</td>
<td>ISDB-T</td>
</tr>
</tbody>
</table>
Conclusions

◆ ISDB-T has launched in Tokyo, Osaka and Nagoya areas. And ISDB-T$_{sb}$ has already launched.
◆ ISDB-T can receive in Mobile/Portable environment.
◆ ISDB-T brings robustness to multi-path interference in fixed reception.
◆ ISDB-T provides effective utilization of Frequency with SFN.
◆ ISDB-T is the most flexible system among the DTTV standards.
What’s merit of ISDB-T for DTTV system?

- Service flexibility and Inter-operability
- Merit of transmission characteristics
ISDB-T Mobile Reception
and Flexibility of services

Note: In case of mobile reception, service area is reduced.

64QAM

Mobile (Data, Music, etc...)

DTV

TV Program 1
(SDTV)

TV Program 2
(SDTV)

Mobile (Data, Music, etc...)

Pocket-size small receiver

DQPSK
How ISDB-T developed?

- Pilot test in Japan
- Development of mobile receiving technology
- Proto type of Digital Audio/one segment receiver
Experiment Broadcast test in Japan

Experiment Broadcast test has been held in 11 area, The purposes of this test are (1) transmission characteristics investigation, (2) Mobile & portable reception capability, (3) Evaluation of digital system, (3) Investigation for digital broadcast new service, etc.

I will introduce the several examples of pilot test image in this seminar.
Experimental Broadcasting in Japan

for new business promoting

Tokyo area started Oct. ‘98

Other 10 Area started April ‘99

-Open to public for business developing and research
Experimental Broadcasting in Japan

for System finalization of ISDB-T

Transmitting started since Oct.'98

Tokyo Tower
Height 210m
CH UHF-15
Power 500W

Existing Analog TV
Ch-14  50kW
Ch-16  10kW

Sawara Stn.

Kanto Area

Tokyo
Mobile Reception

Digital

Analog
The fluctuation situation on electric field strength by mobile reception

Example of fluctuation (bandwidth: 6 MHz)

Example of fluctuation (bandwidth: 1.5 MHz)

Example of fluctuation (bandwidth: 300 kHz)

Example of fluctuation (NTSC Audio carrier)
720P Transmission Experiment
Situation of Demonstration

720P and 480P simultaneous broadcasting

480p and 720p DEC
SDTV 3channels transmission
The drama which a story can choose by liking

Outline

• A channel is controlled by VC (visual code) inserted into the program.
• VC of zapping prohibition is inserted in SD channel so that it cannot move to other channels.

The outline of story deployment of a drama

<table>
<thead>
<tr>
<th>HD channel (common story)</th>
<th>SD:A ch.</th>
<th>SD:B ch.</th>
<th>SD:C ch.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a man meets three ladies.</td>
<td>Kyoko’s story</td>
<td>Yuka’s story</td>
<td>Emi’s story</td>
</tr>
</tbody>
</table>

Selection point 1
A partner is chosen

Selection point 2
A marriage partner is chosen

HD channel (common story)
A hero worries about marriage partner selection

SD:A ch.
moved life with Kyoko

SD:B ch.
moved life with Yuka

SD:C ch.
moved life with Emi
The receiving screen of hierarchical transmission.
Schematic of interactive service for mobile reception
Mobile Reception of ISDB-T on train

- Indoor test result
- Mode3, QPSK, FEC=1/2, GI=1/4
- Max Speed=494km/h
- Field test result
- Tohoku Shin kansen bullet train
  - (Miyagi prefecture Sendai city)
- Constant speed 275km/h
- Mode2,
  FEC=1/2, GI=1/4, T.I=0.43ms, SFN
- Percentage of success on receiving (without tunnel area)
  - QSPK 90.3 %
  - 16QAM 74.5 %
Mobile Reception of HDTV

NHK
Result of Indoor Test on ISDB-T Diversity Reception System

GSM Typical urban area model
Mode3 GI=1/8
64QAM 3/4 I=2
18.255 Mbps

<table>
<thead>
<tr>
<th>Number of Branch</th>
<th>f_{dmax}</th>
<th>Velocity@19ch (v = f_{dmax} × 1)</th>
<th>Velocity@62ch (v = f_{dmax} × 1)</th>
<th>Desired input level (@ f_{dmax} =20Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20Hz</td>
<td>42 km/h</td>
<td>28 km/h</td>
<td>-66 dBm</td>
</tr>
<tr>
<td>2</td>
<td>35Hz</td>
<td>74 km/h</td>
<td>49 km/h</td>
<td>-81 dBm</td>
</tr>
<tr>
<td>3</td>
<td>45Hz</td>
<td>95 km/h</td>
<td>63 km/h</td>
<td>-4 dBm</td>
</tr>
<tr>
<td>4</td>
<td>45Hz</td>
<td>95 km/h</td>
<td>63 km/h</td>
<td>-86 dBm</td>
</tr>
</tbody>
</table>
Result of Field Experiment

Electric field strength [dBuV/m] vs. Percentage of success on receiving [%]

- UHF 19 ch
- Mode3 GI=1/8
- 64QAM 3/4 I=2

Number of used branches:
- 1
- 2
- 3
- 4

NHK
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.
Toyota Central Lab demonstrated HDTV Mobile Reception using Adaptive Array Antenna

UHF 15ch (whole segment reception)
Mode 3, 64QAM, 3/4
Guard interval: 1/8(128 µs)
Threshold C/ N=20.1dB

Reference: http://ne.nikkeibp.co.jp/DTV/2003/01/1000016922.html
Prototype digital radio receiver (ISDB-Tsb)

Presented by DRP
Digital Broadcasting Experts Group

ISDB-T one segment
Front-end module and Antenna

- Panasonic announced ISDB-T one-segment front-end module for cellular phone and PDA.
- RF tuner circuit and OFDM demodulator are installed in this module.
- Specifications;
  - Size: 20mm × 28mm × 2mm
  - VHF 7ch, UHF13〜53ch
  - Length of the antenna: 50mm
  - Power Consumption: 200mW
  - Modulation: DQPSK and QPSK and 16QAM
One Segment Service of ISBD-T for Cellular Phone

KDDI & NHK  Sanyo  NEC
ISDB-T now in Japan
(Commercial type receiver)
Block Diagram of ISDB-S and ISDB-T

ISDB - Satellite

ISDB - Terrestrial
Key Technology for DTV Systems

- MN88415 (June’99)
- MN2WS0002B H (June’00)
- MN67754 (June’00)
- MN864602 (June’01)

Digital Tuner

Front-end LSI

Transport Dec LSI

Video Dec. 2D-Graphic Format Conv.

SDRAM

RDRAM

IEEE1394 I/F

BS-Tuner QF20 (July’00)

News Release (May’00)
Core Software PiE-OS Operating System for DTV
Panasonic Announced the Sale of New PDP and LCD TV Sets

- ISDB-T tuner are installed in 37”, 42”, 50” PDP TV and 32”, 26”, 22” LCD TV.
Sony Announced the Sale of New Digital TV Sets

- **New models**
  - PDP 61”, 50”, 42”
    9 models
  - LCD 42”, 37”, 32”
    3 models
  - CRT 28”, 32”, 28”
    3 models
Thank you for your attention!