

Digital Terrestrial Broadcasting in Japan (ISDB-T System)

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Part 3; HDTV Mobile Reception

1. Outline of Digital Broadcasting in Japan

Japan's Profile

- **Population** **127 million**
- **Number of households** **48 million**
- **Area of Japan** **378,000 km²**
- **TV receivers** **100 million**
- **Terrestrial TV networks**
 - **3-9 stations/region with many relay stations (including 2channels by public broadcaster, NHK)**
 - **NHK: reception license fee based, nation wide network**
 - **Private broadcasters: regional based (30 regions in Japan)**
 - **5 major networks + independent stations**

The Merits of Digital Broadcasting

HDTV



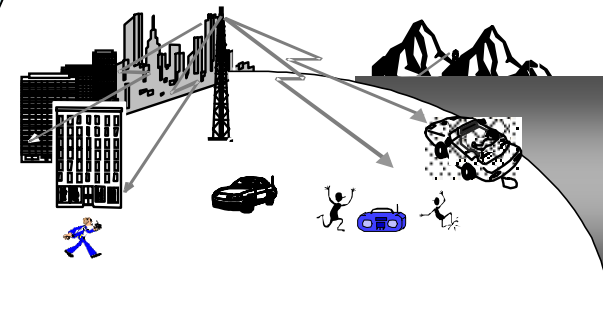
Multiple programs



Data broadcasting



Mobility

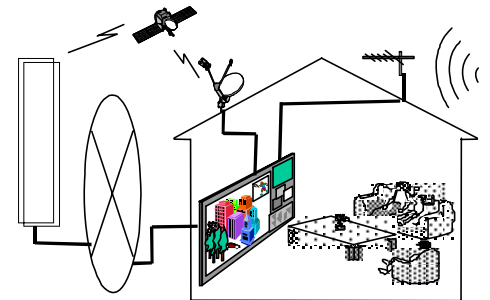


Merits

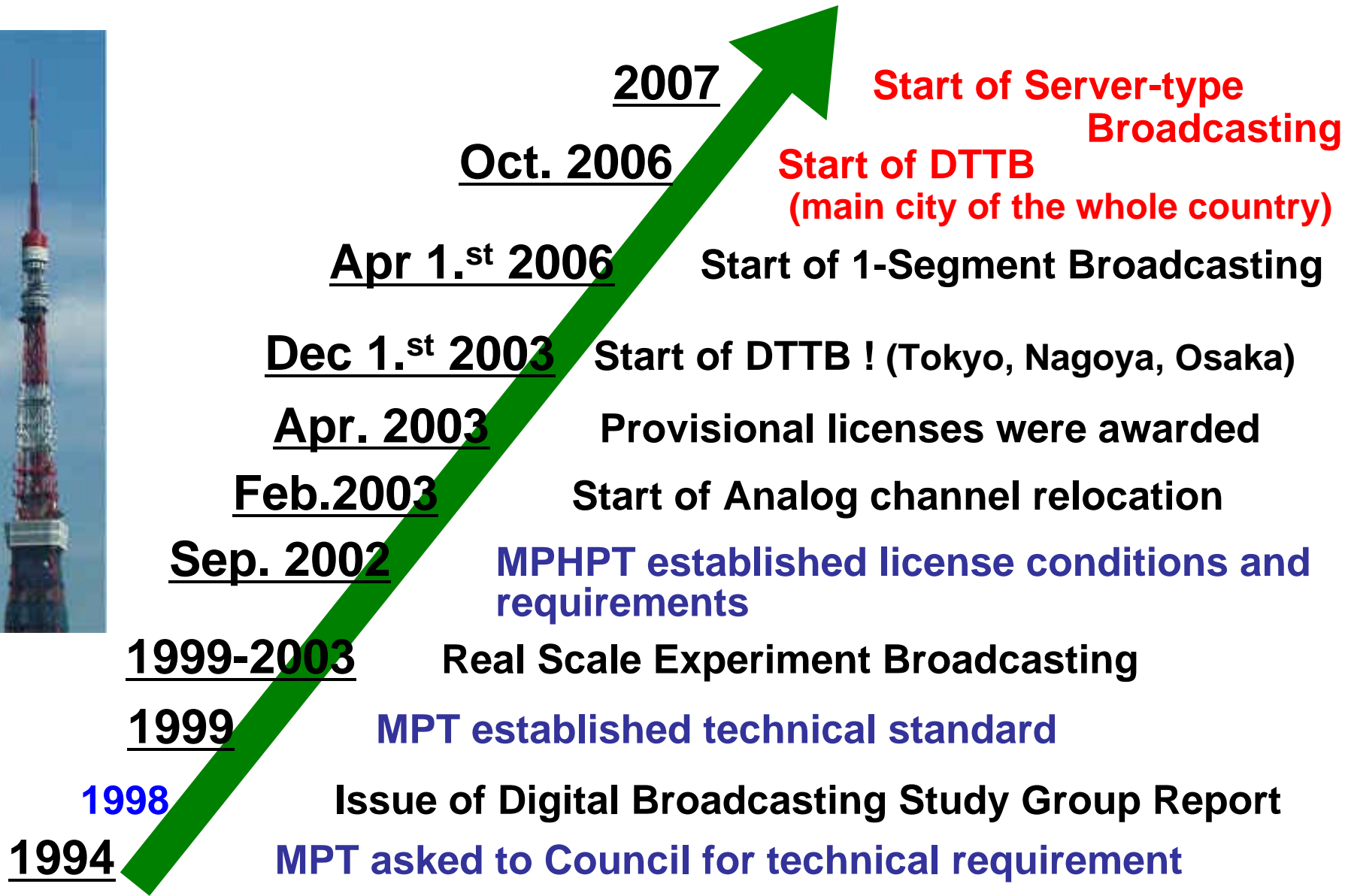
Advanced caption etc.



Interactive TV



Implementation Schedule of Digital Terrestrial Television Broadcasting in Japan



Expansion Schedule for DTTB in Japan

In the seat of Prefectural Government,
DTTB . . .



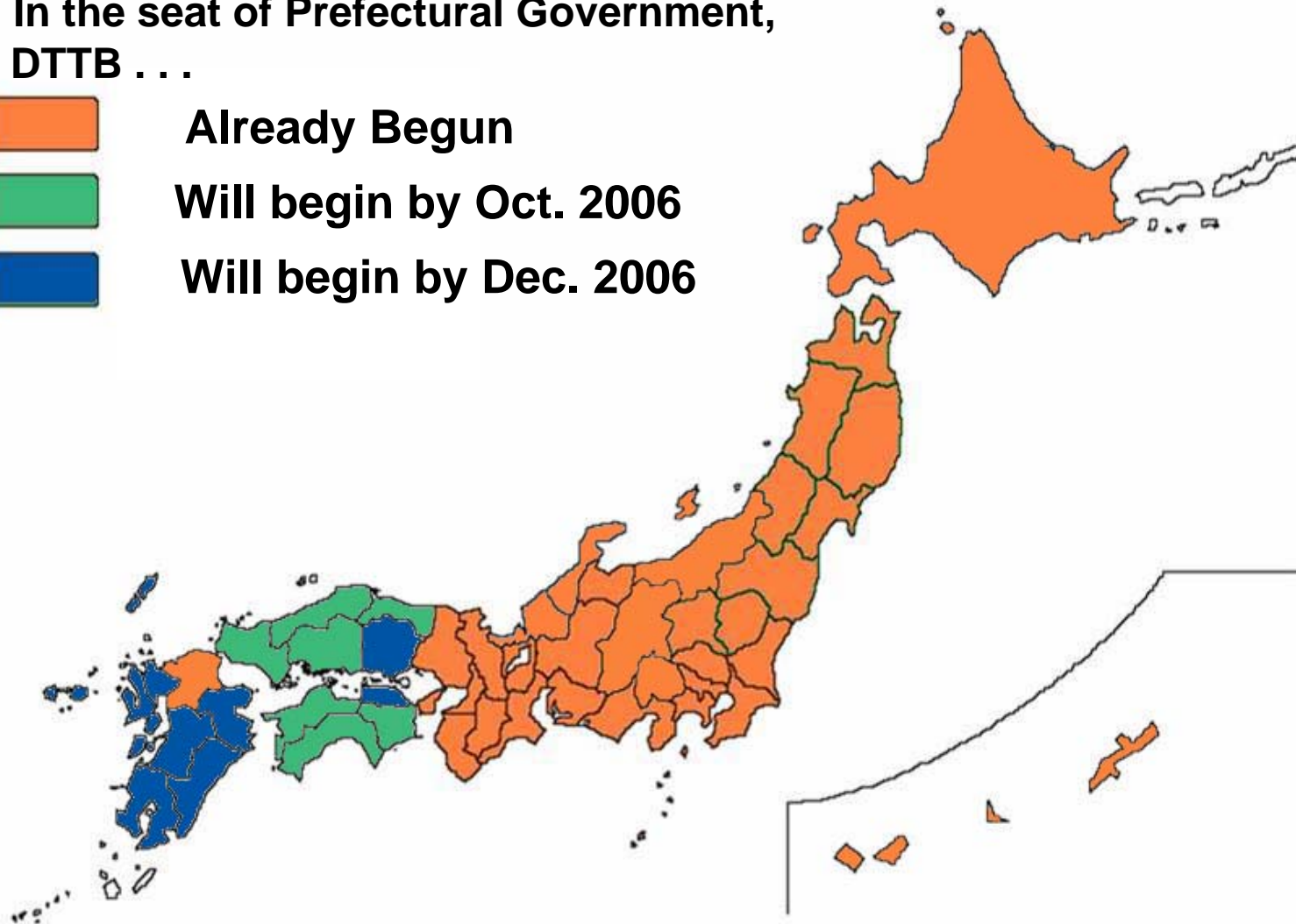
Already Begun



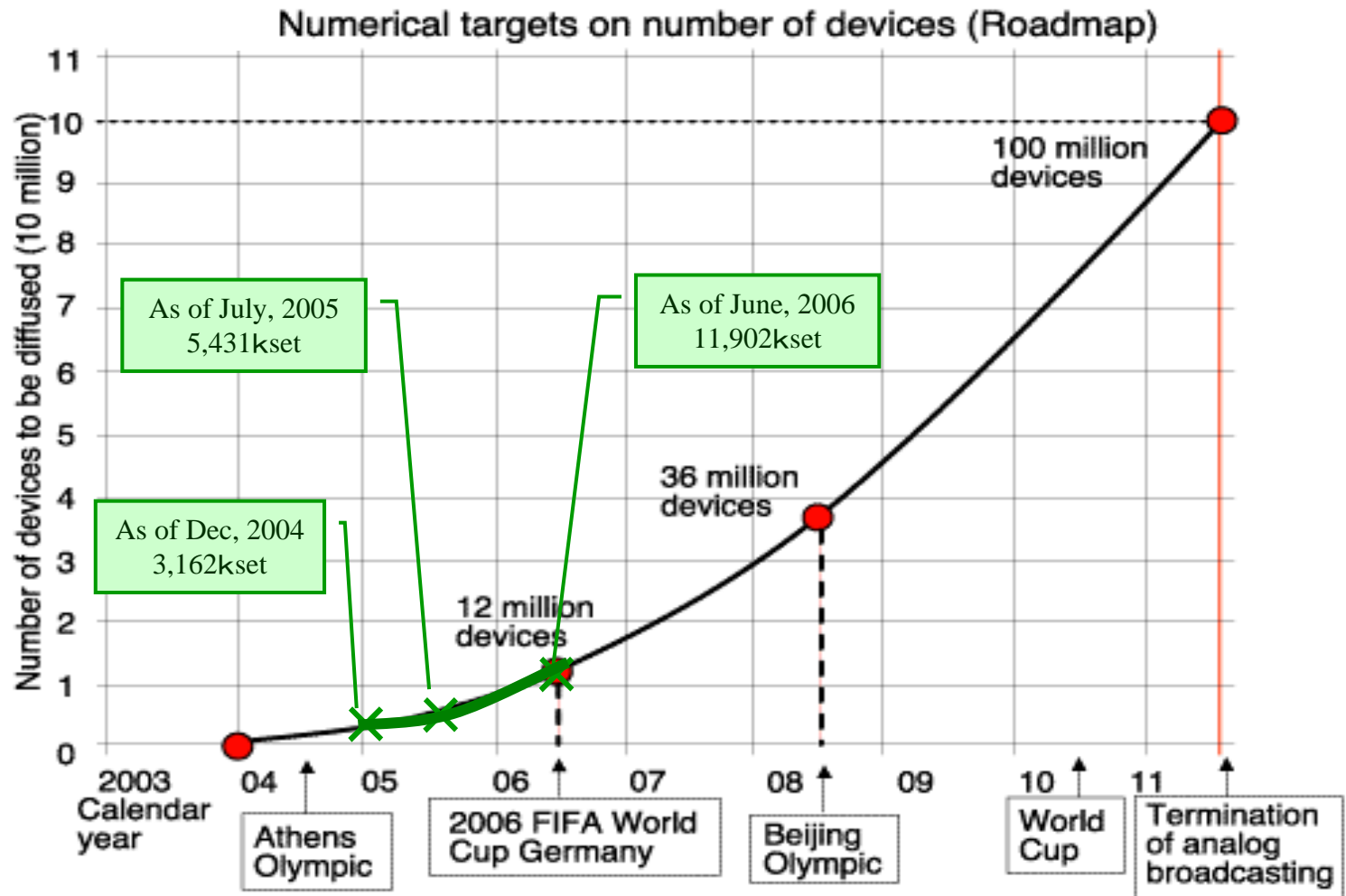
Will begin by Oct. 2006



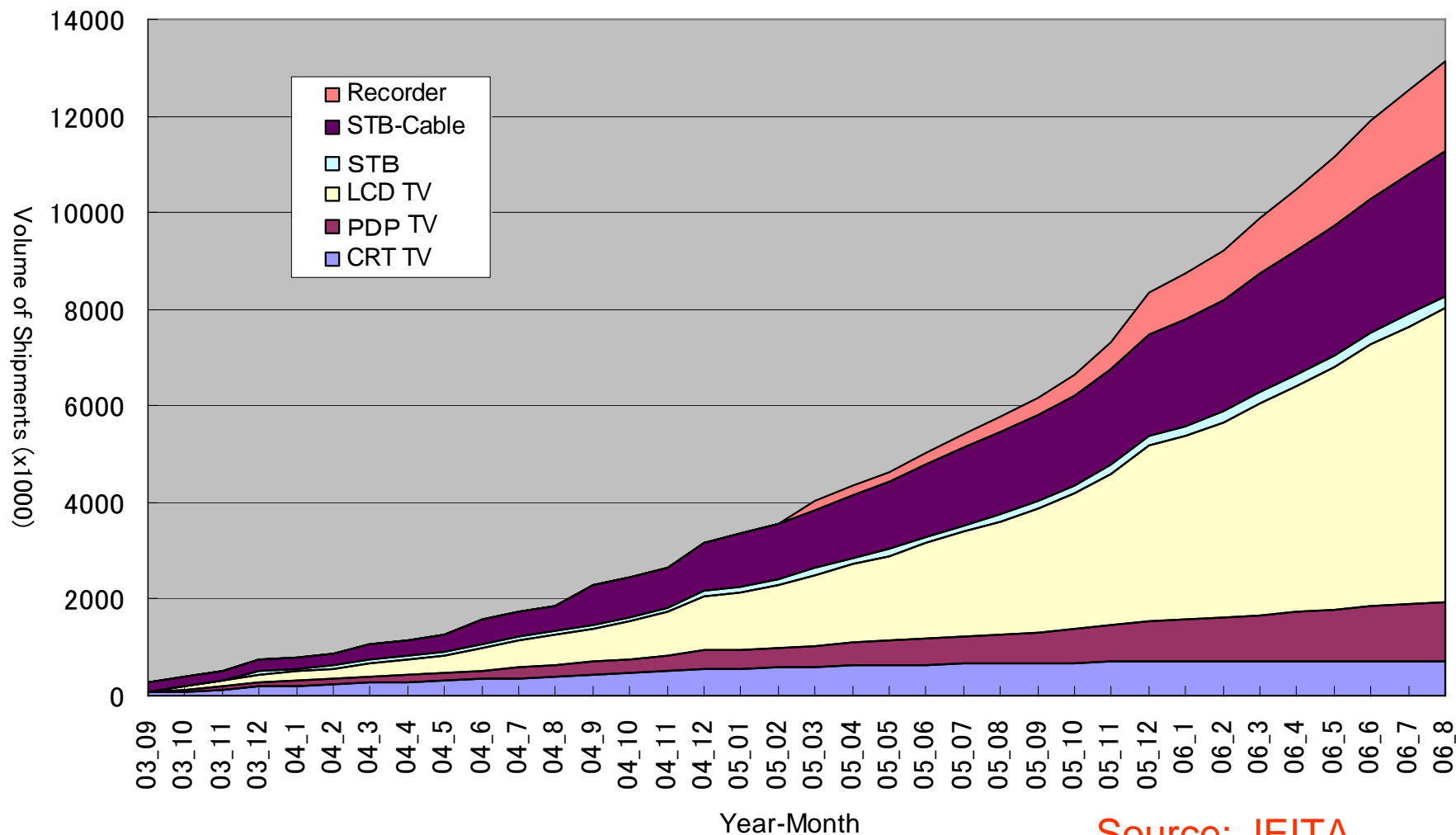
Will begin by Dec. 2006



Targets on Diffusion and Shipment Volume of Digital Terrestrial TV Receivers



The Cumulative shipments of DTTB Receivers



Source: JEITA

Licensing Policy for Digital Terrestrial Television Broadcasting

- ❑ Over 2/3 simultaneous broadcasting of analog programs per day**
- ❑ HDTV program time quota of more than 50% for all Digital terrestrial television broadcasters**
- ❑ Broadcasting using subtitles and commentary**

Strategy to Promote Digital Terrestrial Television Broadcasting

- ❑ End of Analog Broadcasting; **July 2011** mandated by Radio Law
- ❑ Promote Digital terrestrial television broadcasting receivers
- ❑ DTV as integrated home information terminal
- ❑ Need of collaborative work among government, broadcasters and industry

2. 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

Requirements for Digitalization

Multimedia-service

High-Quality TV/ Multi-Channels

Flexible/Versatile

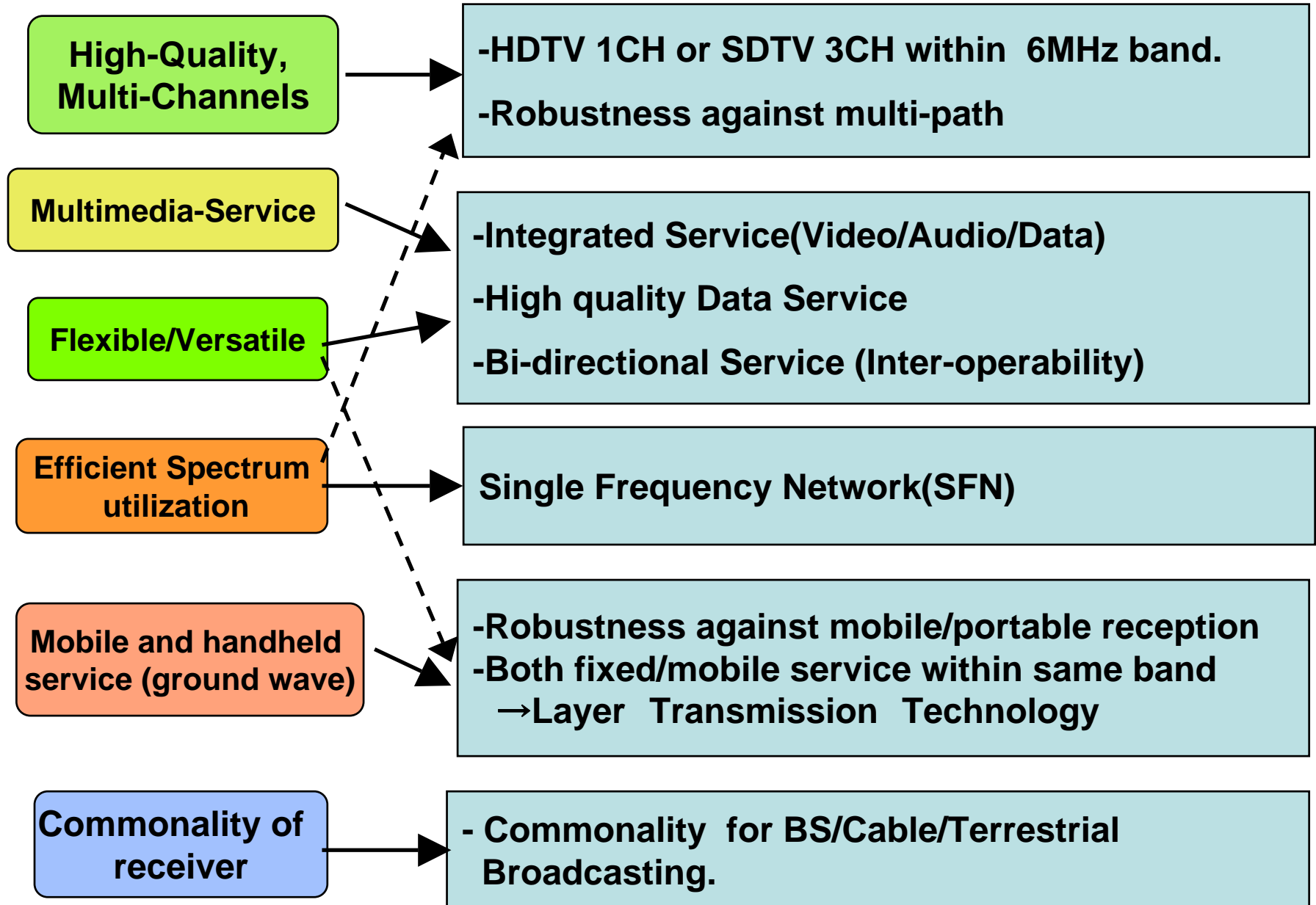
Effective frequency utilization

Mobile and handheld service (ground wave)

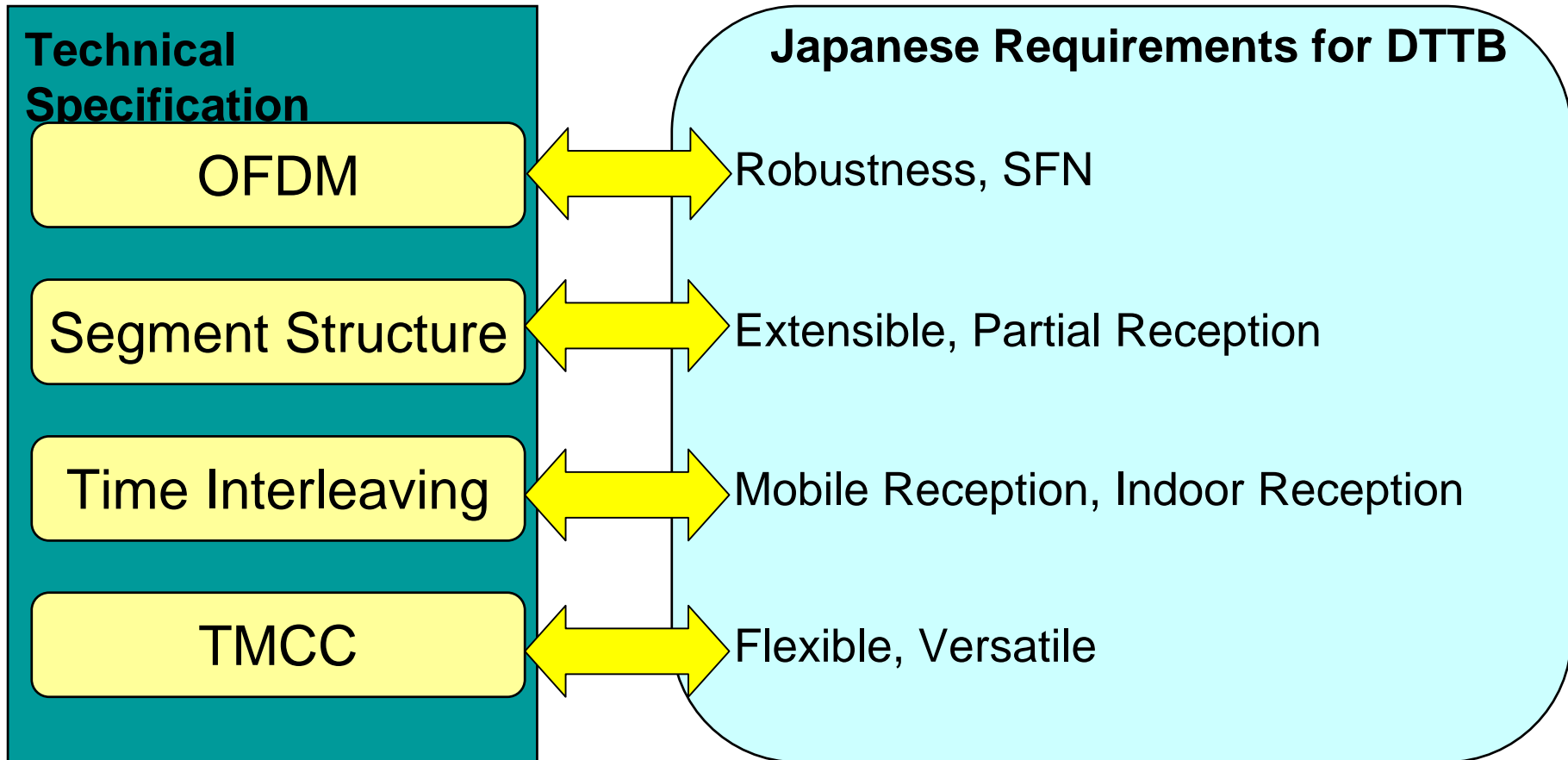
Commonality of receiver

At first, the requirement of digital broadcasting should be established.
The requirements described above are for digitalization in Japan.

Requirements for Digitization → Solutions



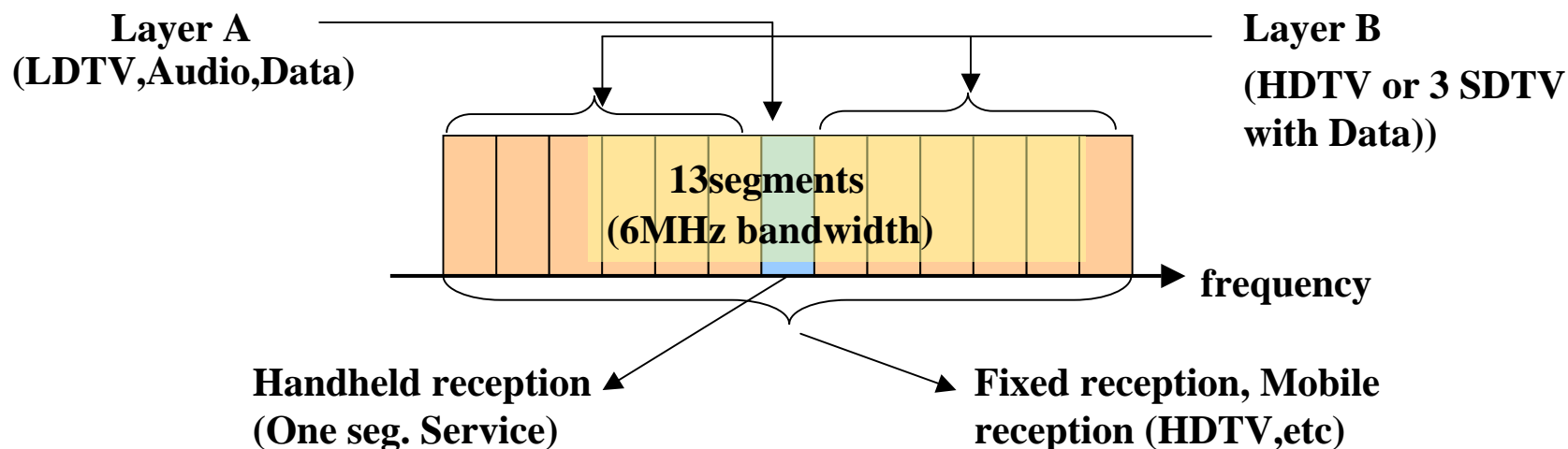
Features of ISDB-T Transmission System



What is Segmented OFDM with time interleave?

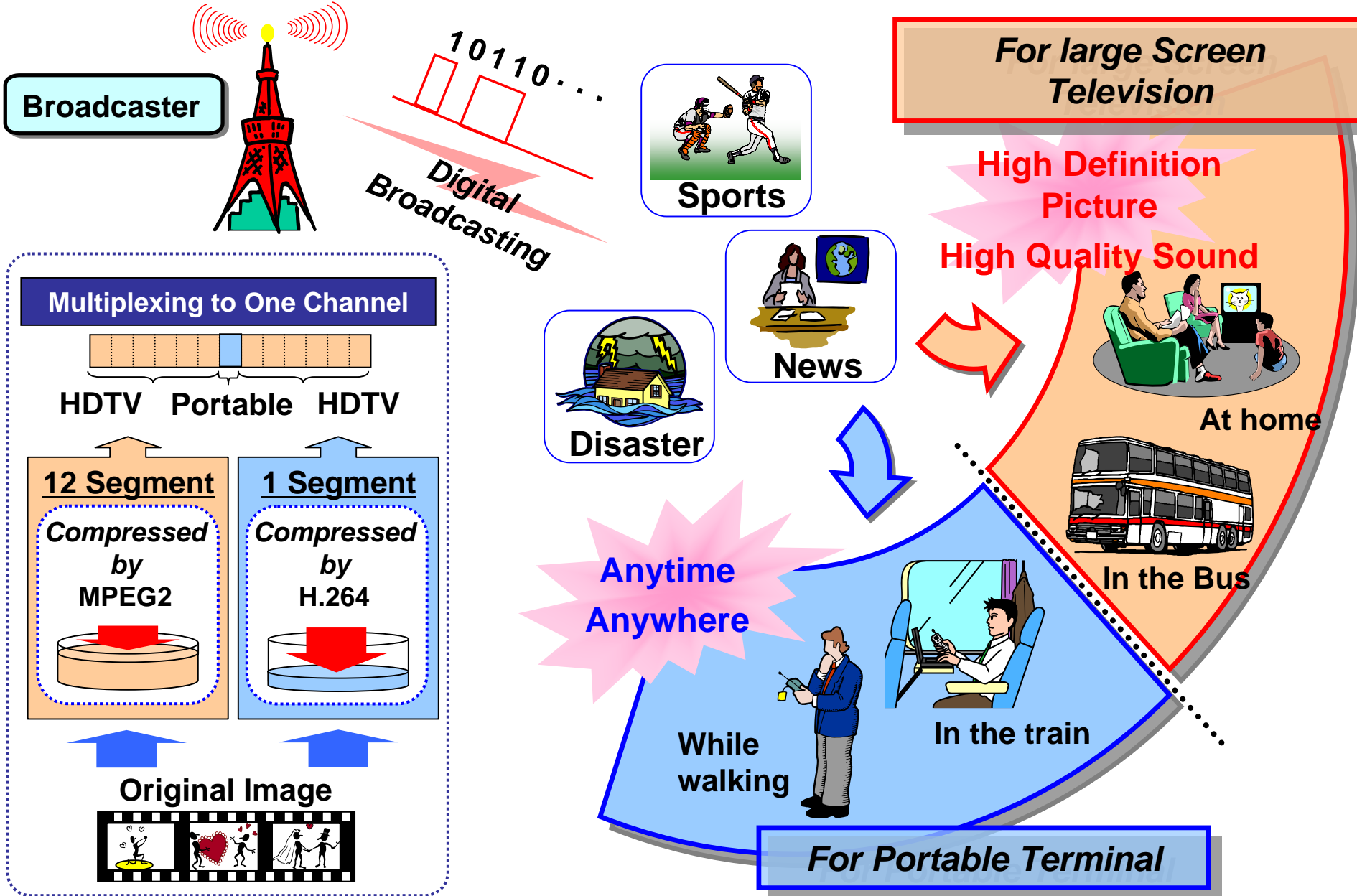
Feature of Japan's Digital Broadcasting system

- (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)



- 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)

Service Image of ISDB-T in Japan



3. Comparison of 3 DTTB Systems

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

Broadcasting Services

<i>System</i> <i>Item</i>	<i>ATSC</i>	<i>DVB-T</i>	<i>ISDB-T</i>
HDTV/ SDTV Fixed reception	⊙	⊙	⊙
Data broadcasting	⊙	⊙	⊙
SFN	×	⊙	⊙
HDTV Mobile reception	×	×	⊙
		(○ SDTV)	
Portable reception with cellular phone	×	△	⊙
Internet access	×	△	⊙

Effect of Time Interleaving

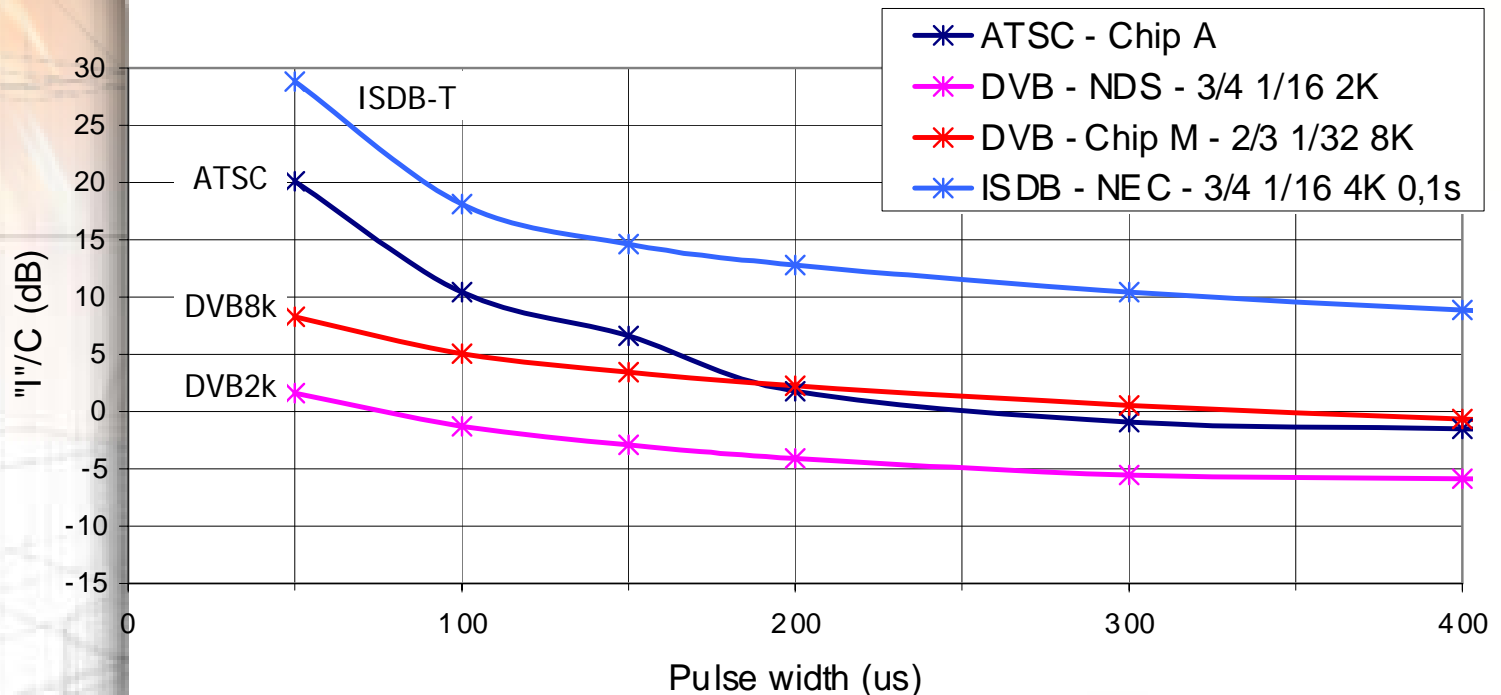
- As the experimental result, time interleaving improve required CN ratio about 7 dB in mobile environment on 16QAM.
- Diversity system improve about 7dB on 16QAM.
- Time interleaving (time diversity) work independently from space diversity.
- That is the reason for advantage of ISDB-T in mobile environment.
- 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

Impulse Noise

Relation between the noise pulse width & interference to signal ratio

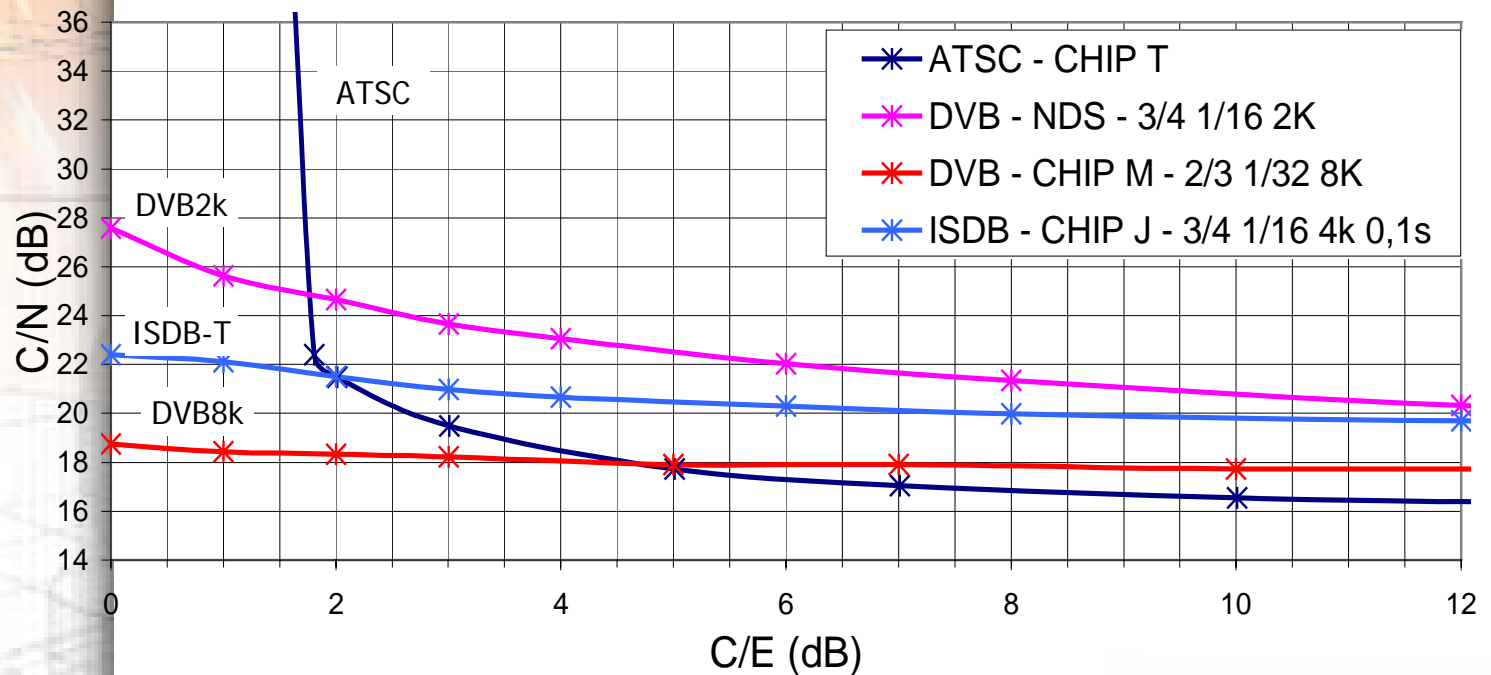


- Better performance of the ISDB-T system, by introducing time interleaving

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

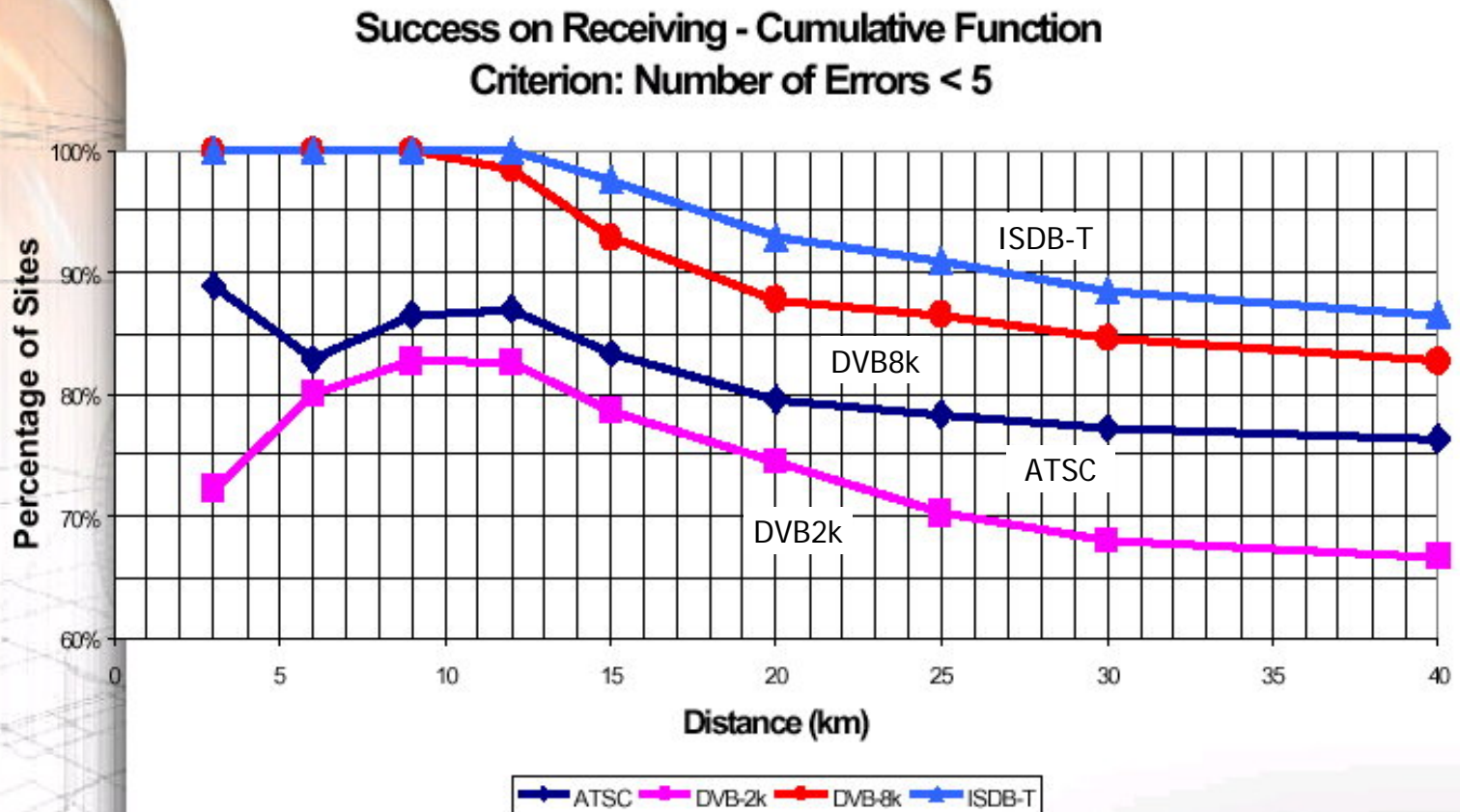
Static Multipath

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



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

Outdoor: Coverage



(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.

Requirements	System conform to requirements
Maximum bit rate under Gaussian noise environment	ATSC
Robustness against multi-path distortion	DVB-T, ISDB-T
Robustness against impulse noise	ISDB-T
Wide area single frequency network (SFN) operation	DVB-T, ISDB-T

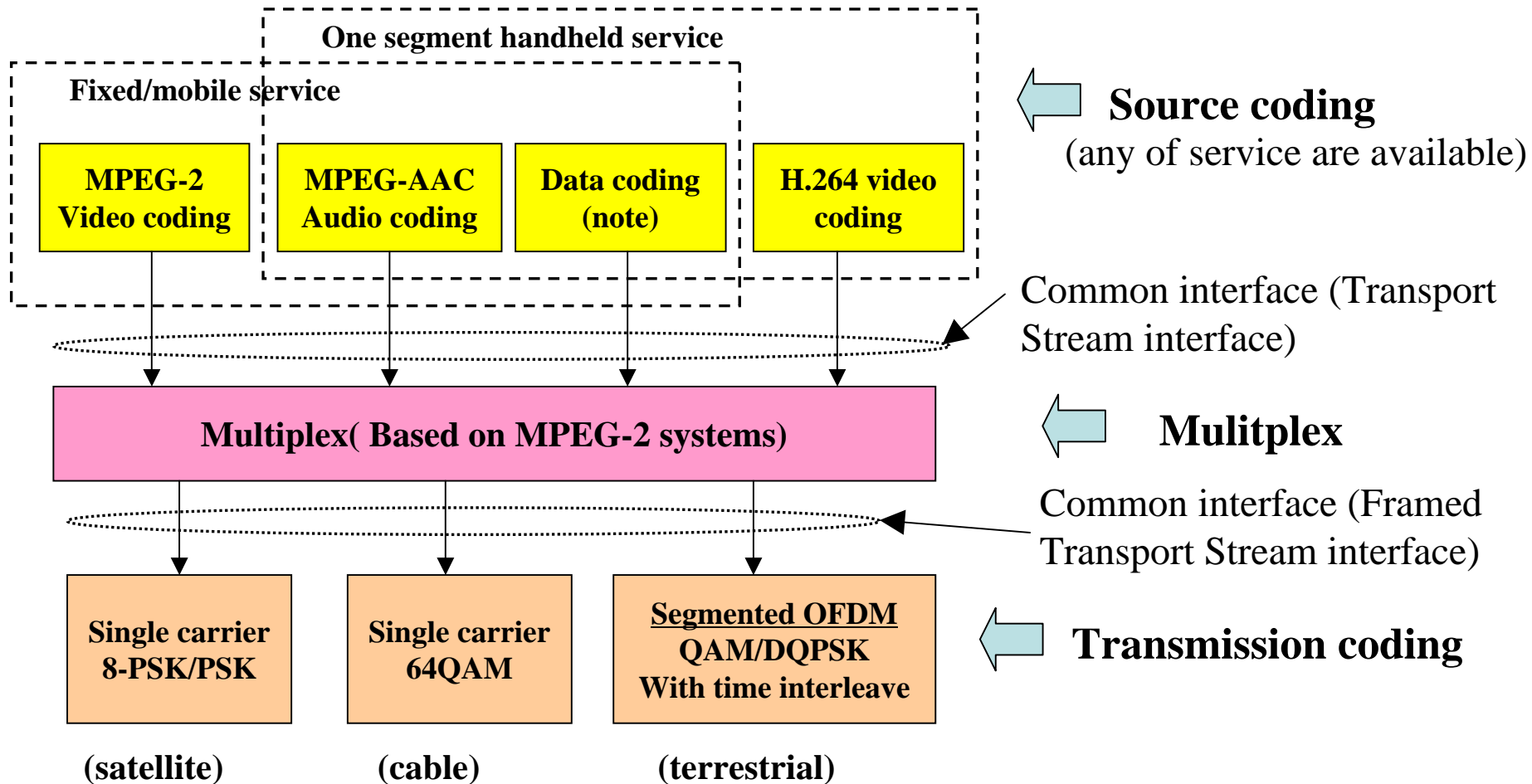
Summary of Comparison(2/2)

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

Requirements	System conform to requirements
Mobility and Portability	ISDB-T >> DVB-T
Hierarchical transmission (Multiple modulation systems simultaneously in the same channel is possible)	ISDB-T >> DVB-T
System commonality with digital terrestrial sound broadcasting (One segment receiver is available)	ISDB-T

4. Structure of ISDB-T Standard

Structure of Japan's Digital Broadcasting system



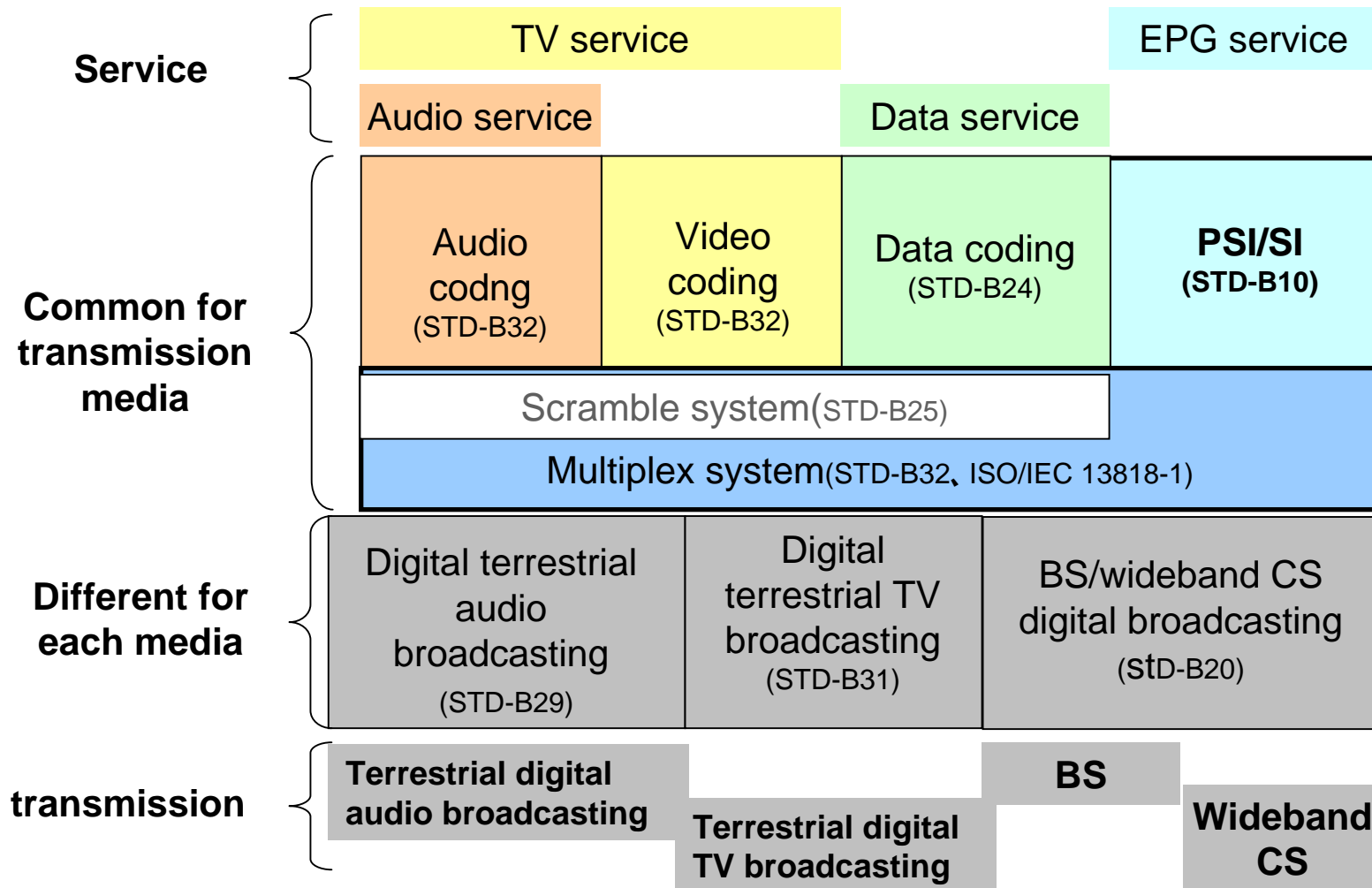
(note) both BML and MHP are available,
But in Japan now BML is only service in.

ARIB Standards for Digital Broadcasting

	Digital Television		Digital Sound	
	BS / wCS	Terrestrial	Terrestrial	Satellite
System	STD-B20	STD-B31	STD-B29	STD-B41
Multiplex	Coding & Multiplexing		STD-B32	
	Service Information		STD-B10	
Source coding	Coding & Multiplexing		STD-B32	
Data Broadcasting	Presentation Engine (BML)		STD-B24	
	Execution Engine (GEM-based)		STD-B23	
CAS	Conditional Access		STD-B25	
Home servers	System based on Home Servers		STD-B38	
Receivers	STD-B21		STD-B30	STD-B42
Operational Guidelines	TR-B15	TR-B14	TR-B13	TR-B26

Digital broadcasting & Multiplex system

Structure of Digital broadcasting



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

Parameters of ISDB-T (6MHz Bandwidth)

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

5. Current Service of ISDB-T in Japan

(part 1; Total Image)

Unique Features of Japan's Digital Broadcast

HDTV



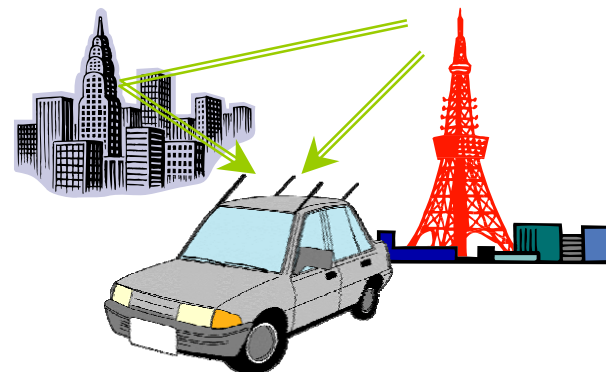
- High quality image and sound service.

Data broadcasting



- Simple program searching and retrieval of information at any time.

Mobile reception



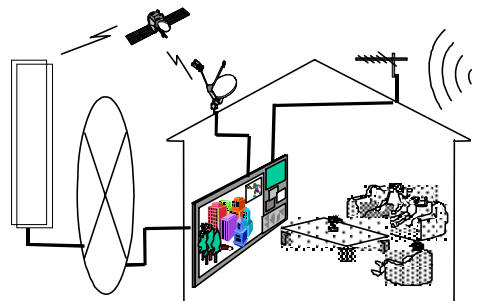
- Stable reception service

Multi-channel service



- Realization of multiple channels

Interactive TV



- Communication services and linked TV service

HDTV

□ High Definition Broadcast

- ✓ Most powerful application*
- ✓ The quality images on the wide, 16:9 aspect ratio screen and CD-quality sound make you feel as if you were there.*
- ✓ European broadcasters have opted for “multi-channel” strategy, however Japan’s broadcasters have chosen the advantages of “high definition” pictures.*

✓ Pure HDTV : 16x9 1080i



Multi channel SDTV

- *The bandwidth of a single digital channel can be used to transmit two or three programs with standard definition simultaneously.*
- *Multi-channel approach is presently positioned as an “experimental” .*



SD-1



SD-2



SD-3

Data broadcasting (1)

□ ***Data broadcasting is now on service.***

- ✓ *Weather information*
- ✓ *Anytime news*
- ✓ *Result of sports game*
- ✓ *Information associated TV program*

Players list



Ongoing games



A example of soccer game

Other games result



Other information



Data broadcasting (2)

Current programme screen



Player's list



Games schedule



Other games results



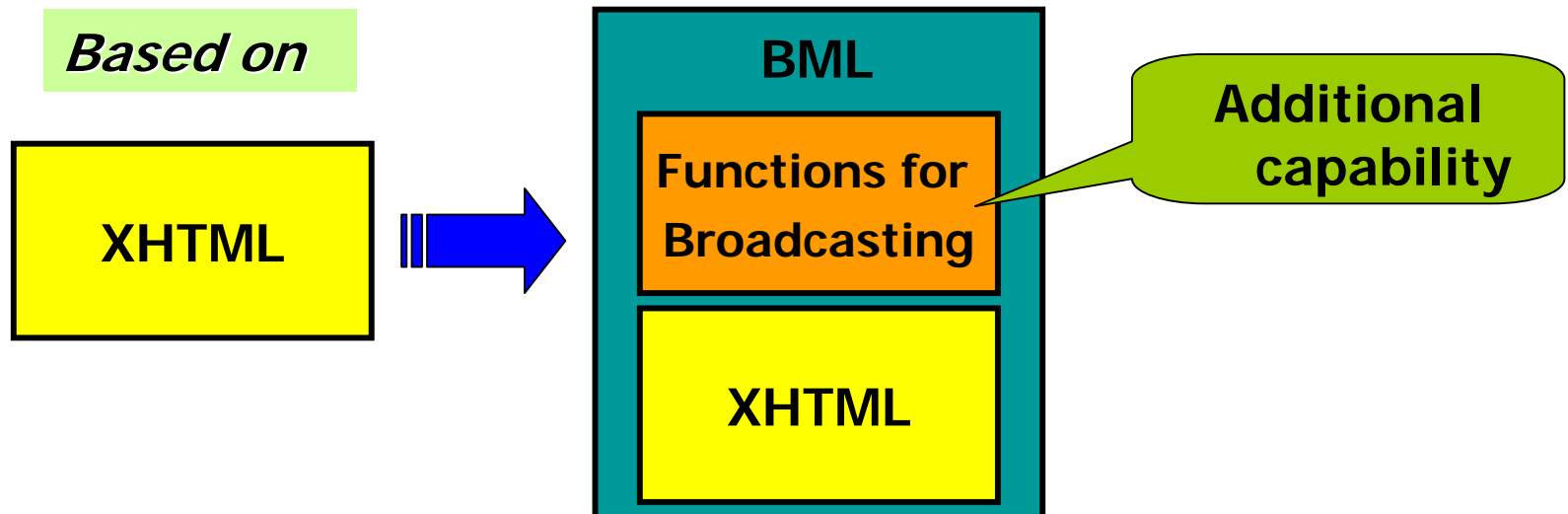
Data broadcasting (3)

❑ *Description language is BML format*

❑ *Features*

✓ Easy creation of contents

✓ Affinity for internet



EPG

❑ EPG (Electronic Program Guide)

- ✓ *An electronic programme guide (EPG) is a on-screen guide to scheduled broadcast television programs, allowing a viewer to navigate, select and discover content by time, title, channel, genre, etc, using their remote control.*



5. Current Service of ISDB-T in Japan (part 2; Portable Reception – One Seg)

One-Seg service (1)

- *One segment service launched from April 1st, 2006 .*
- *One-Seg is abbreviation of one segment service.*
- *Common logo was designed as shown below.*



One-Seg

One-Seg service (2)

□ The One-Seg service sends images to mobile phones, car TV's, personal computers etc. so that you can enjoy digital terrestrial television broadcasting program anytime anywhere.

□ Merits

- ✓ Stable reception in a mobile environment.*
- ✓ High quality of video & audio in a mobile environment.*
- ✓ Robust to noise and multi-pass.*

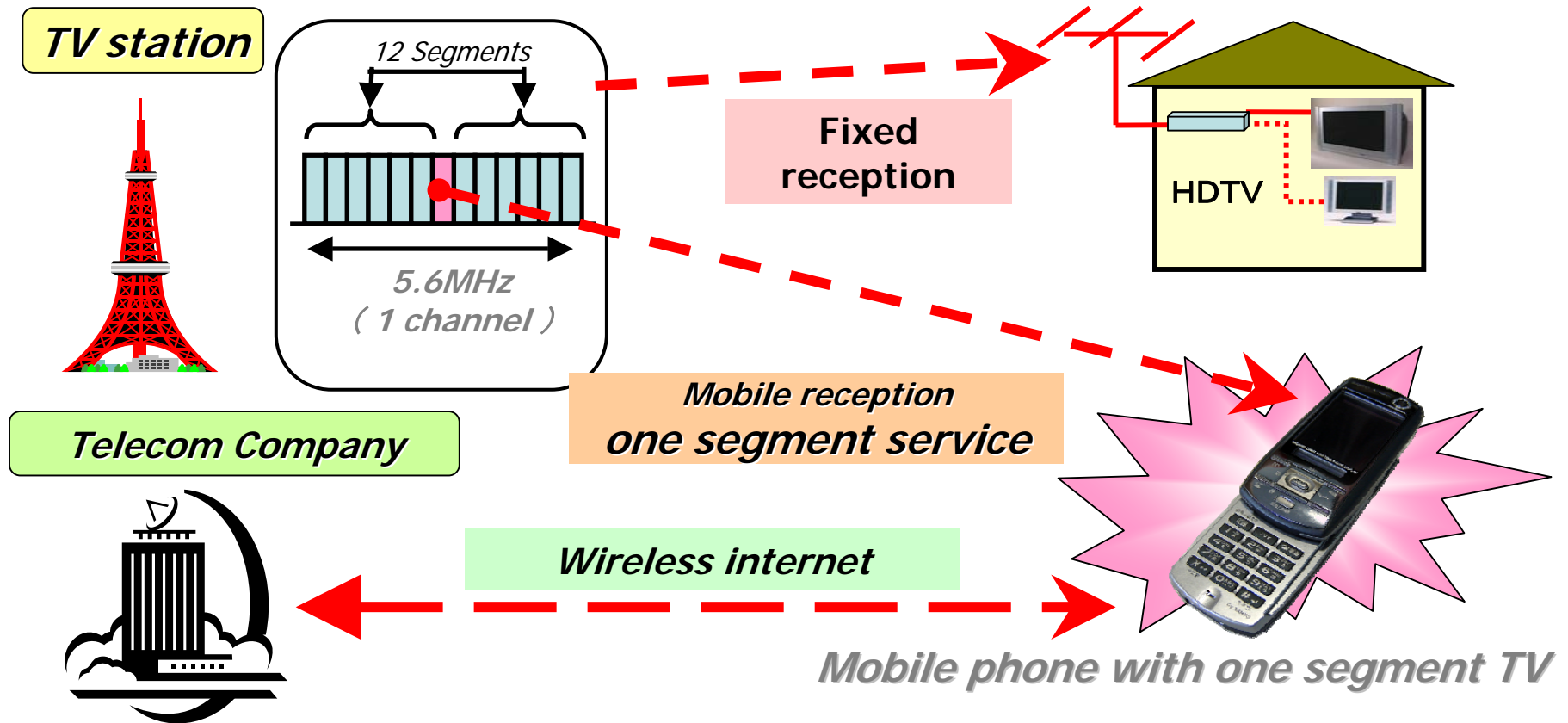
One-Seg service (3)

Comparison between ISDB-T and other systems

	<i>ISDB-T</i>	<i>Other Systems</i>
<i>Transmission method</i>	ISDB-T One-seg service	T-DMB (KOR) DVB-H (mainly EU) Media FLO (US)
<i>Service application</i>	Video / Audio / Data	Video / Audio / Data
<i>Assignment of new spectrum</i>	Not necessary	Necessary
<i>Additional license</i>	Not necessary	Necessary
<i>Service provider</i>	Broadcaster	Broadcaster / Carrier / Other company

One-Seg service (4)

□ *ISDB-T has a capability of segmentation in a channel and one seg TV uses only one segment as partial reception.*



One-Seg service (5)

Data rate



Video (H.264)

approx. 180-256kbps

Audio (AAC-SBR)

approx. 32-64kbps

Data-cast (BML)

approx. 20-80kbps

One-Seg service (6)

*Fusion of
communication and broadcasting
Jump to internet site !*



Click!



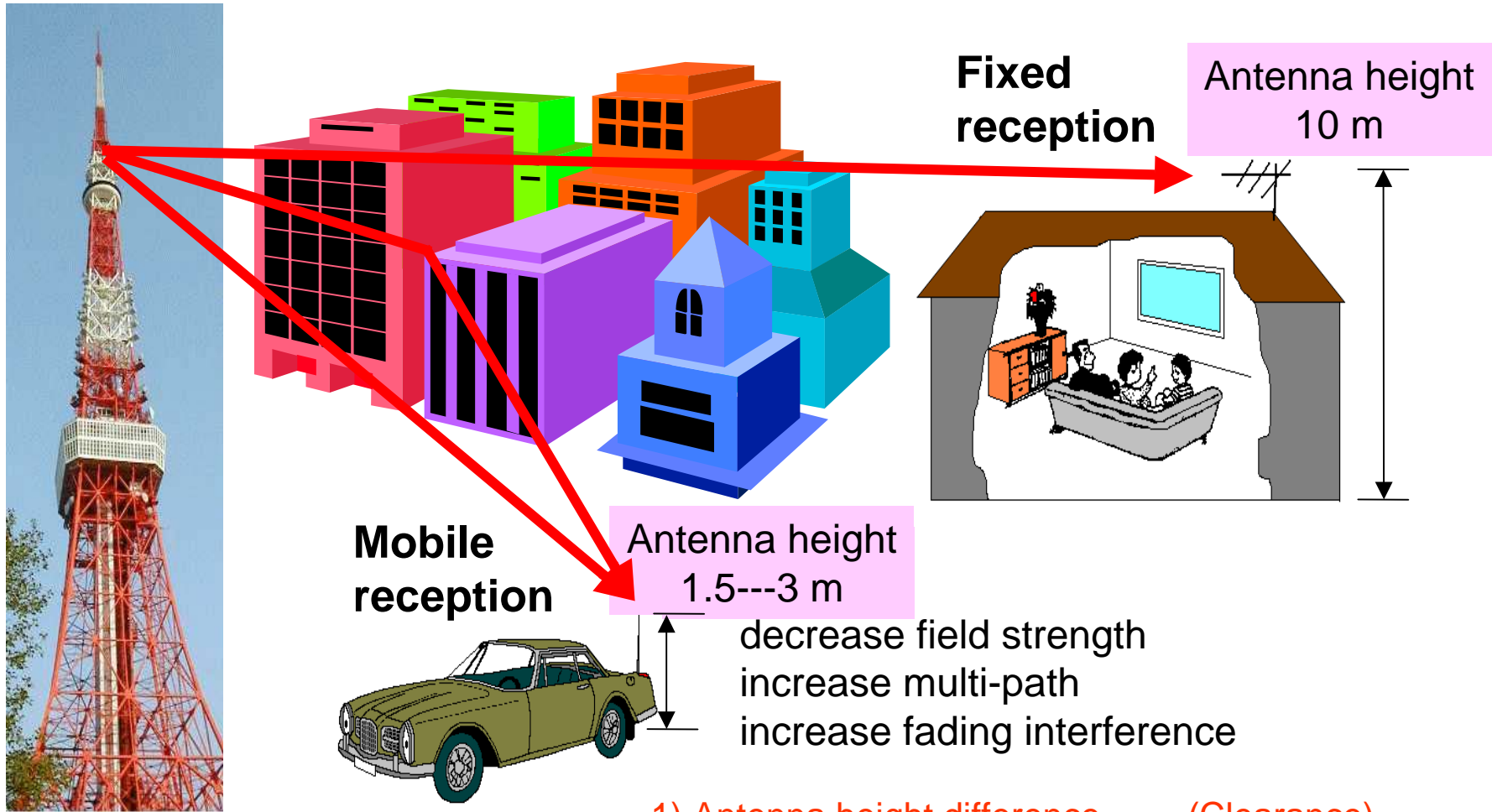
Broadcaster's site



Internet site

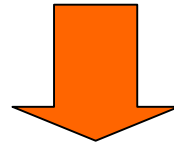
5. Current Service of ISDB-T in Japan (part 3; Mobile HDTV Reception)

Difference between fixed and mobile reception environments



- 1) Antenna height difference (Clearance)
- 2) Receiving antenna difference (Antenna gain)
- 3) Field strength fluctuations (Multipath fading)

Why is mobile reception available?
What kinds of technologies are used ?



1. Feature of transmission system

→ Time interleave (see next page)

2. Adopt new technology for reception

→ Space diversity reception

Space diversity reception technology for OFDM signal;

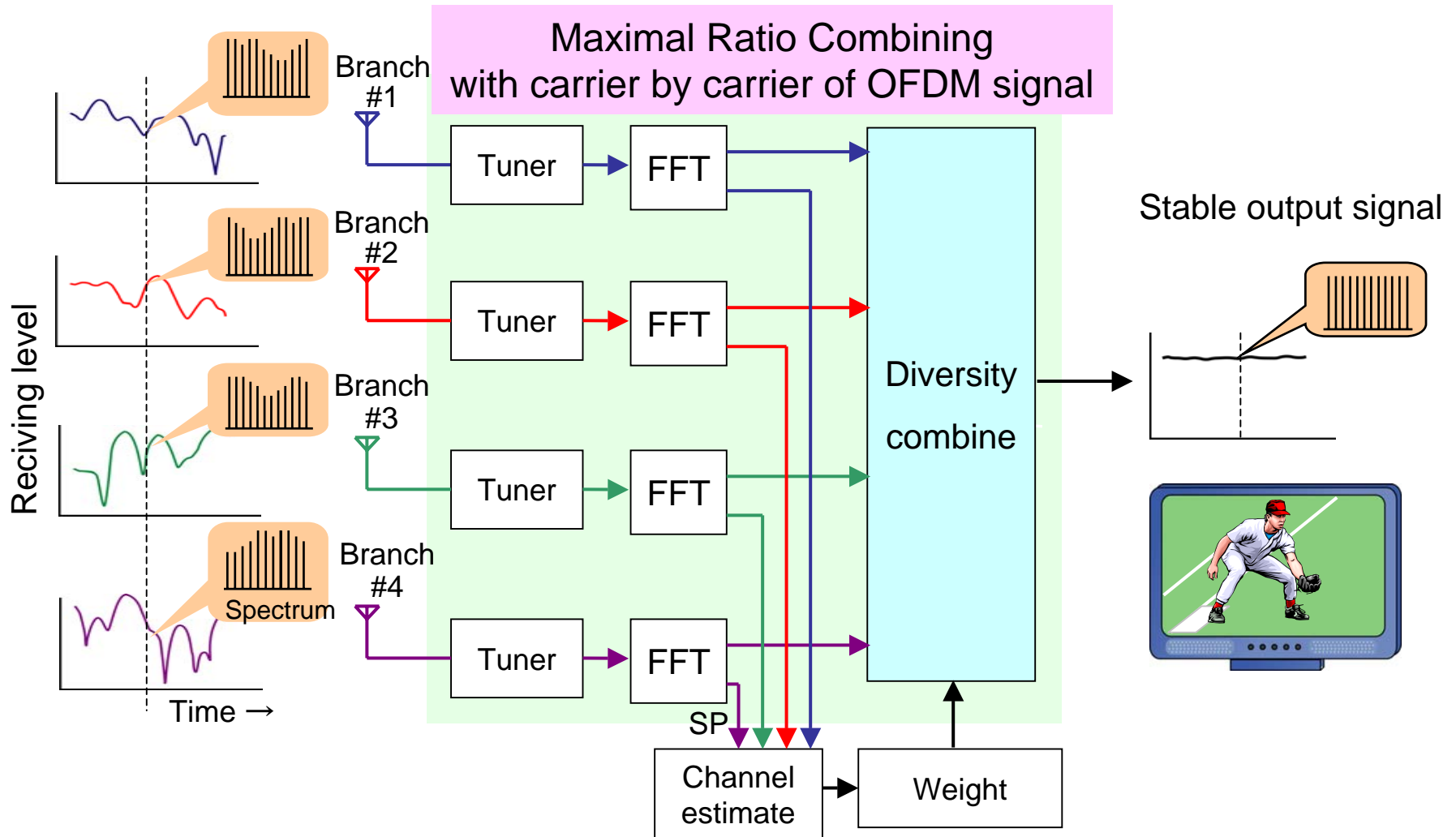
Very unique technology is used ,that is, “maximum ratio combining for each OFDM subcarriers”.

This technology is very effective against frequency-selective fading

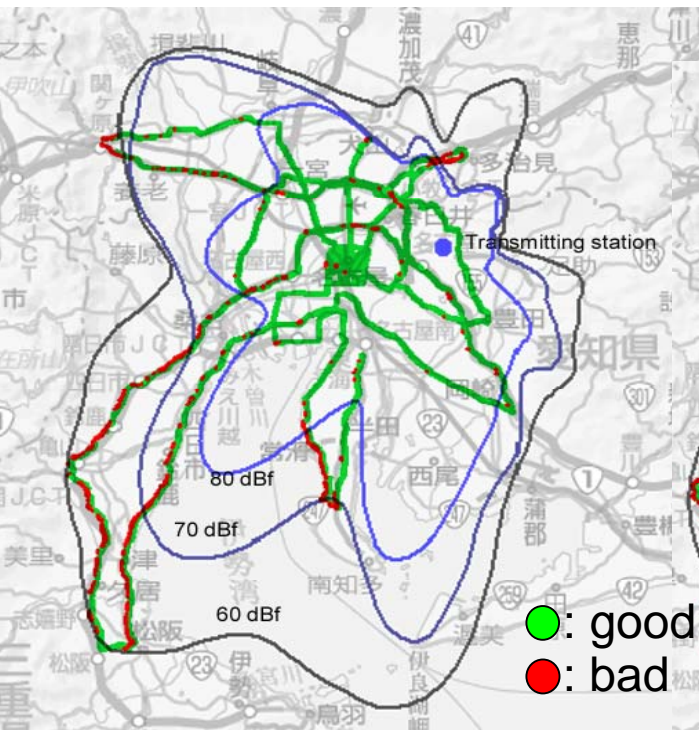
Prototype 4-branch space diversity for HDTV mobile reception

- NHK's prototype diversity reception system for HDTV mobile reception
 - Signal : 6MHz BW 64QAM-OFDM (ISDB-T)
 - Application : HDTV (14 Mbps) in a mobile car
 - Diversity : 4-branch space diversity
- Implementation and performance evaluation
 - Laboratory test
 - Maximum Doppler frequency in fading environment
 - Field trial in Nagoya wide-service area

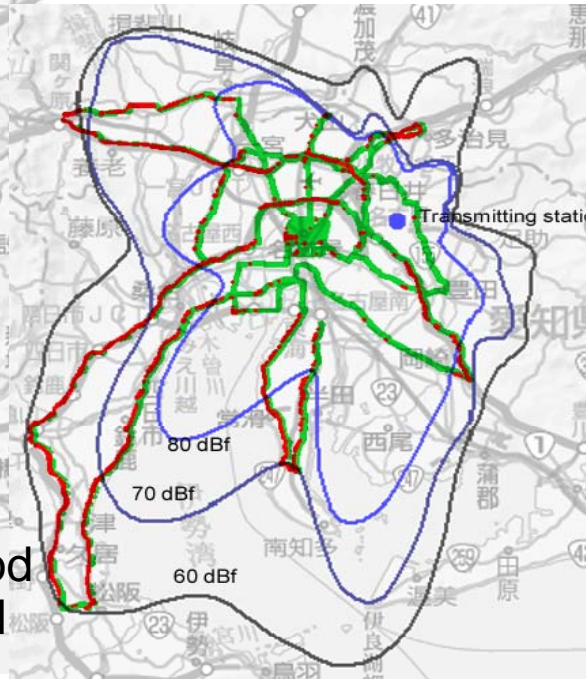
Block diagram of diversity reception system



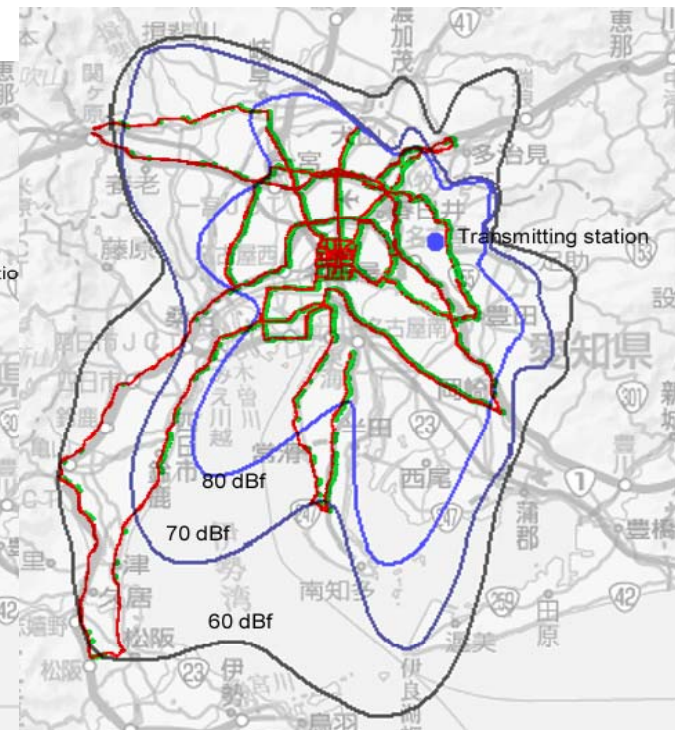
Comparison of receiving areas by branch numbers



4-branch

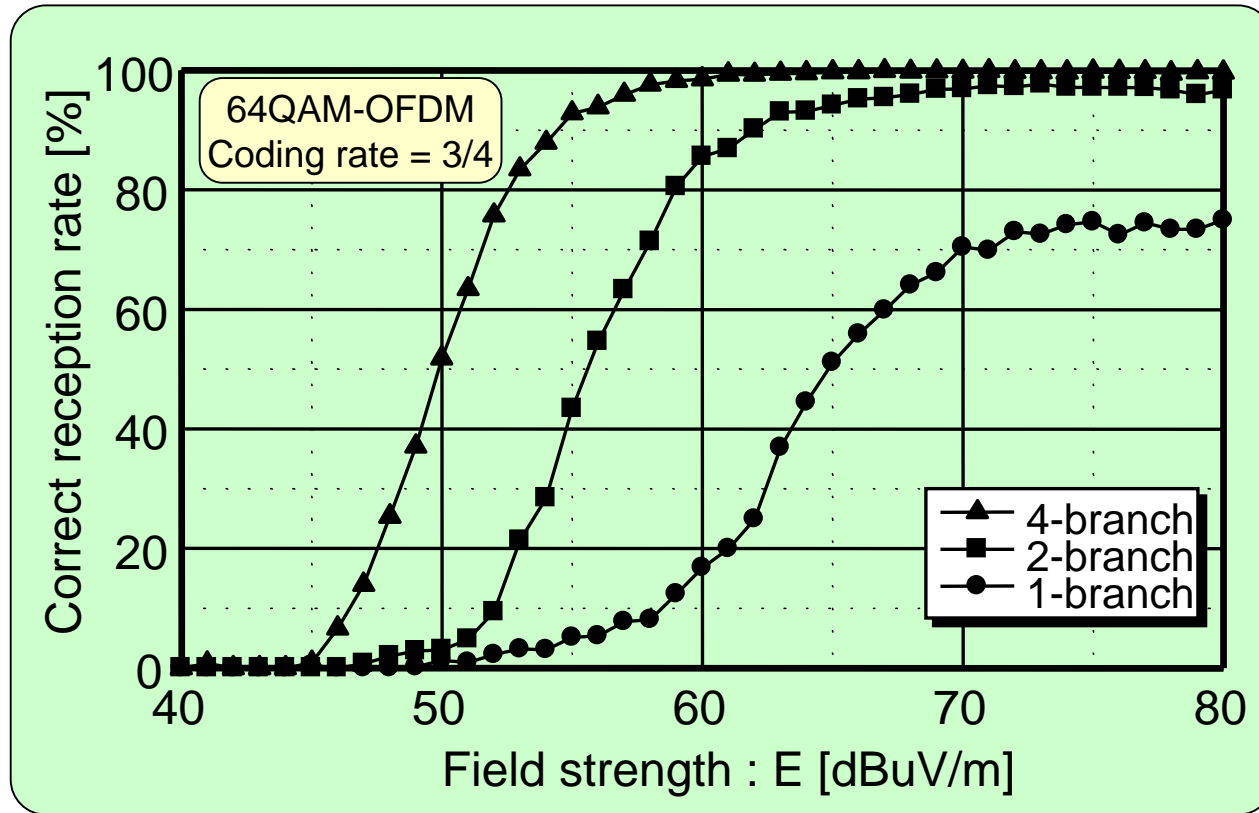


2-branch



1-branch

Correct reception rate vs. received field strength (total)



No. of branches	More than 95% CRR
4-branch	56 dBuV/m
2-branch	65 dBuV/m
1-branch	Not obtained

$$CRR = \frac{Ncd(Ei)}{Nsd(Ei)} = \frac{N\{[(E+1) > E_i \geq E] \text{ and } (PER = 0)\}}{N[(E+1) > E_i \geq E]}$$

6. Digital Receivers on Market

Fixed Reception type Digital Receiver



(Plasma type)



(LCD type)



(CRT type)



(Rear Projection type)

SET TOP BOX



SONY DST-TX1



PANASONIC TU-MHD500



SHARP TU-HD200

Cellular Phones for ONE-SEG Broadcasting



PCs with DTTB tuners

One-seg

SONY



※画像はVGN-TX92S

SONY



Tuner



FUJITSU



DTTV Receivers for Car-Navigation Systems

Tuners One-seg /12seg



Car-Navigation Systems with DTTB tuner



Panasonic

One-seg /12seg



One-seg



SANYO



One-seg /12seg

DVD Player and Audio Player

Portable DVD/SD/CD Player
with one-seg receiver



HDD Audio Player
with one-seg receiver



127 hours
programs
recordable



TOSHIBA

Conclusion

1. ISDB-T is the only one system which enable fixed/mobile/portable reception service in one channel!

- (1) Save frequency resource (not necessary for portable reception service separately)
- (2) Save the broadcaster's infrastructure cost (Only one transmitter for different service)

2. ISDB-T uses OFDM technology for transmission system

- (1) Save the frequency resource by using SFN technology

3. ISDB-T adopt Segment transmission system with time interleave

- (1) Enable portable reception service (One seg) in same channel
- (2) Enable the HDTV mobile reception (receive same signal as fixed reception)
- (3) Enable indoor reception service because of the robustness against signal level fluctuation

4. Enable service flexibility by using MPEG systems for multiplex

- (1) Any type of TV service are available; HDTV, Multi-channel SDTV, One-seg LDTV, Data service and interactive service
- (2) Future development is also available to include into digital TV service

Conclusion

5. Support any type of multi-media service

- (1) ISDB-T includes 2 types of multi-media service, one is presentation engine type (BML), which is defined in ARIB STD-B24, other is the execution engine type, which is defined in ARIB STD-B24
- (2) Presentation engine type service data-casting is now in service in Japan and very popular.

5. Current market

- (1) More than 12 million digital receivers were sold in Japanese market
- (2) More than 1 million portable receivers were sold in 5 months!
- (3) Various type receiver are now in market, also STB is available.

6. Bandwidth

- (1) Prepare the standard for 6.7, 8 MHz system. 6 MHz system is most popular (Japan and Brazil). The market of 6 MHz system is very big!

Thank You for Your Attention!