Presentation 4

System of ISDB-T
Part 2: Transmission system

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KBP ISDB-T Seminar

Manila, Philippines

DiBEG JAPAN

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Contents

1. 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 OFDM Transmission with Time Interleave.**

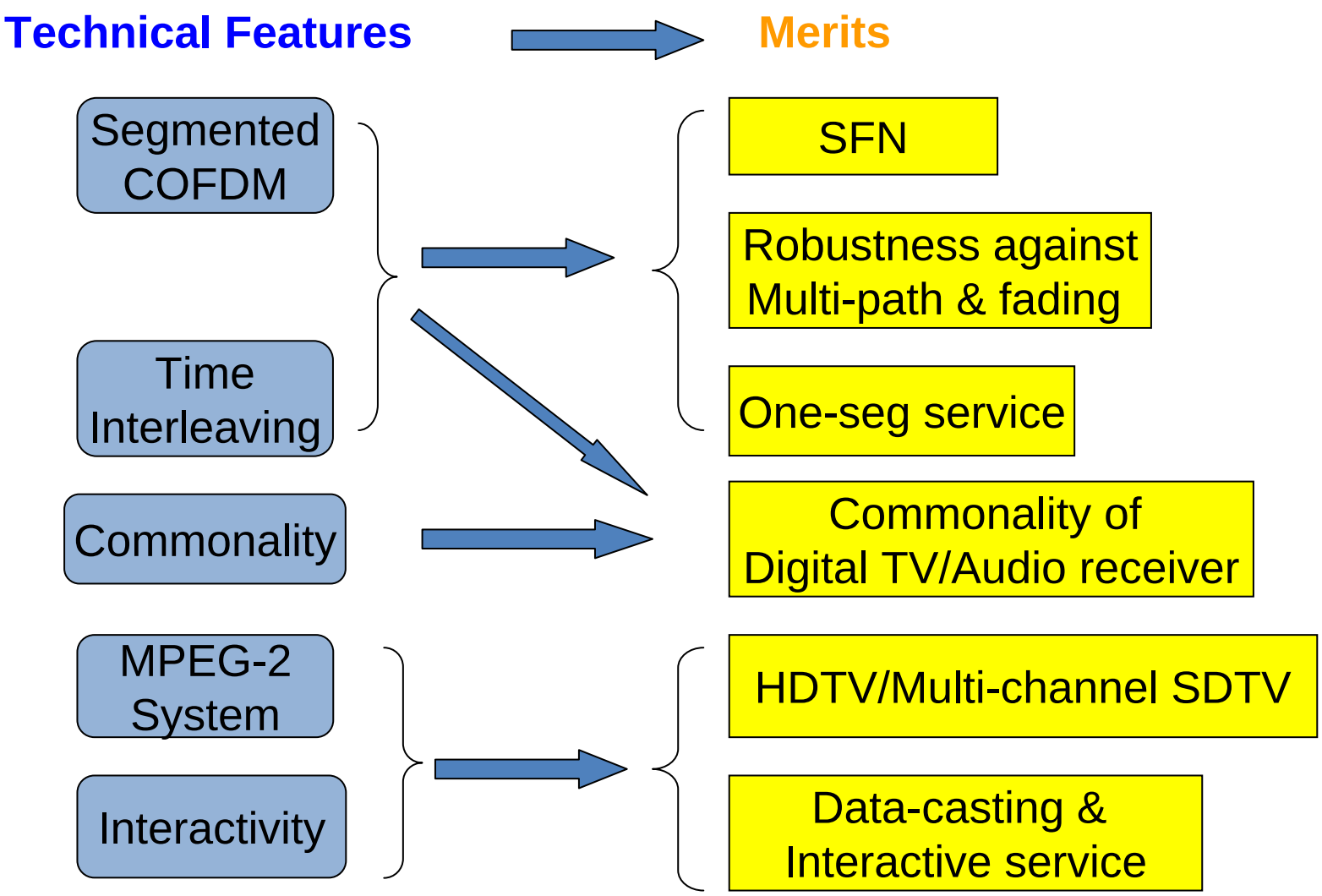
2. Requirement/Solution

2.1 Requirement for ISDB-T

No.	Item	Requirement	Note
1	High quality	HDTV should be possible in 6MHz bandwidth	
2.	Robustness	Robustness against multi-path, urban noise, fading and any other interference	
2. 2(1) 2(2)	Flexibility Service Flexibility Reception flexibility	 Any kinds of service are possible in 6MHz bandwidth Any kinds of reception system are possible, fixed/mobile/portable in same bandwidth	 HD/SD possible
3	Effective utilization of frequency resource	SFN(Single Frequency Network) is possible to reduce frequency.	
4.	Interactivity	Harmonization with network	
5	Data casting		
6.	Commonality	Maximum commonality is need to reduce receiver cost. Especially, to digital radio, common standard is desirable.	

See DiBEG homepage for details

What are Features?



(Details of Merit)

SFN

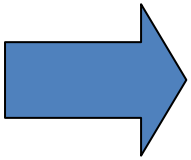
Robustness against Multi-path & fading

One-seg service

Commonality of Digital TV/Audio receiver

HDTV/Multi-channel SDTV

Data-casting & Interactive service



- Save frequency resource
- Clear picture (free from ghost)
- **Mobile/portable reception**
- **Indoor reception**
- **One transmitter for fixed/ portable reception service**
- **Common receiver is available**
- **High quality TV service**
- Service flexibility
- Independent data service
- Data associated TV
- Harmonization with Internet

Service Image of ISDB-T in Japan

One transmitter supports any kind of service

Broadcaster

10110...

Digital Broadcasting

Sports

News

Disaster

Multiplexing to One Channel

HDTV Portable HDTV

12 Segment

Compressed by MPEG2

1 Segment

Compressed by H.264

Original Image

For large Screen Television

High Definition Picture
High Quality Sound

At home

In the Bus

Anytime
Anywhere

In the train

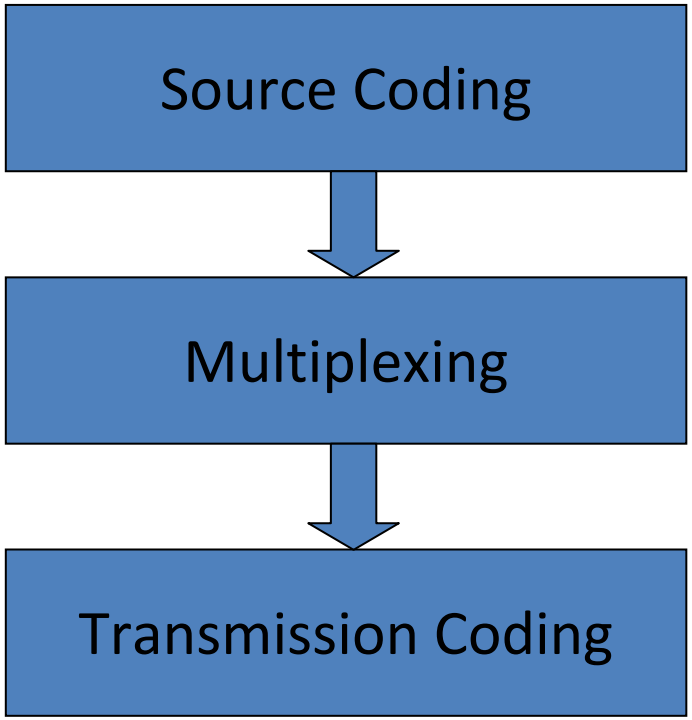
While walking

For Portable Terminal

3. Structure of ISDB-T Standard

- **Structure of Japan's Digital Broadcasting system**

General View of Structure

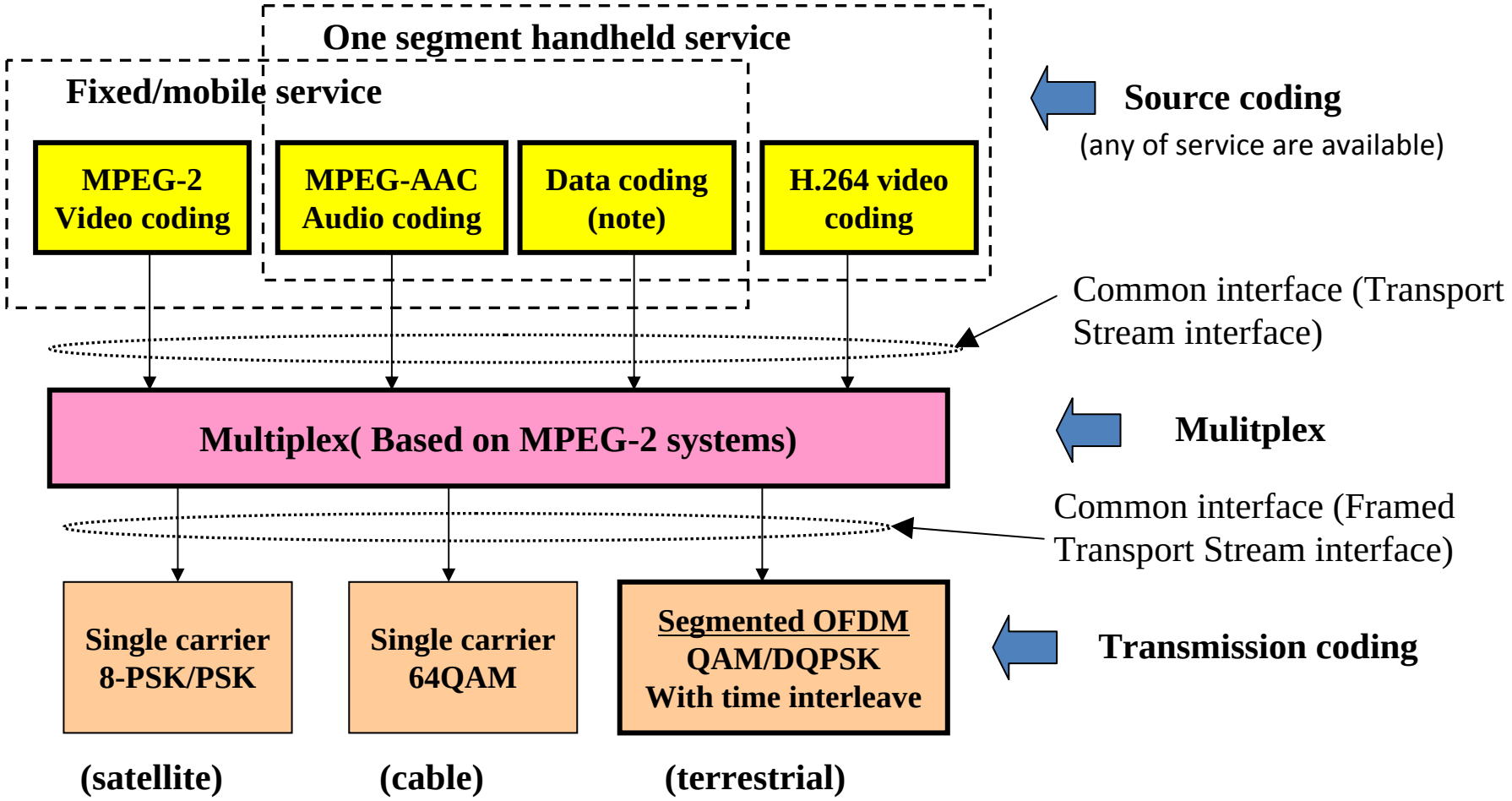


- Common for all Broadcast media to keep commonality
- Any services are available

- Multiplex all data from Source coding
- Interface to transmission media by TS format

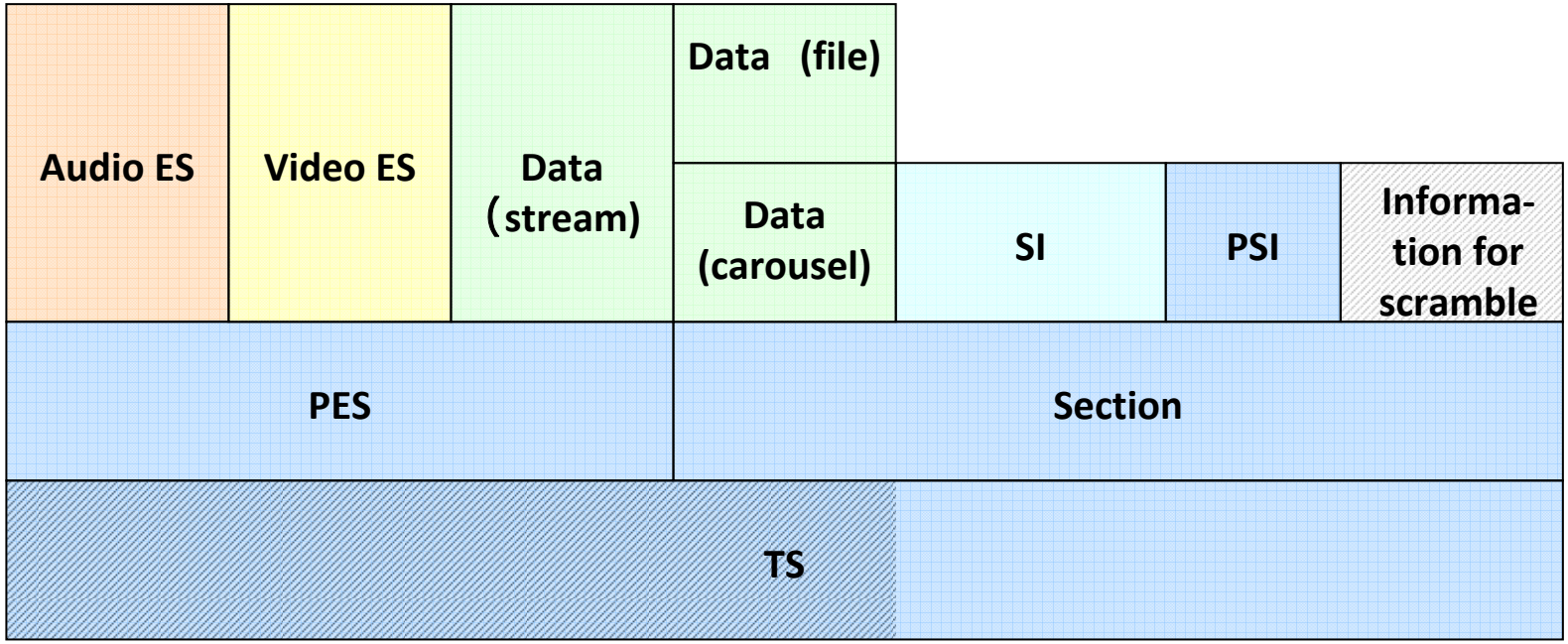
- Modulation system is optimized for each media

•Continued (details of structure)



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

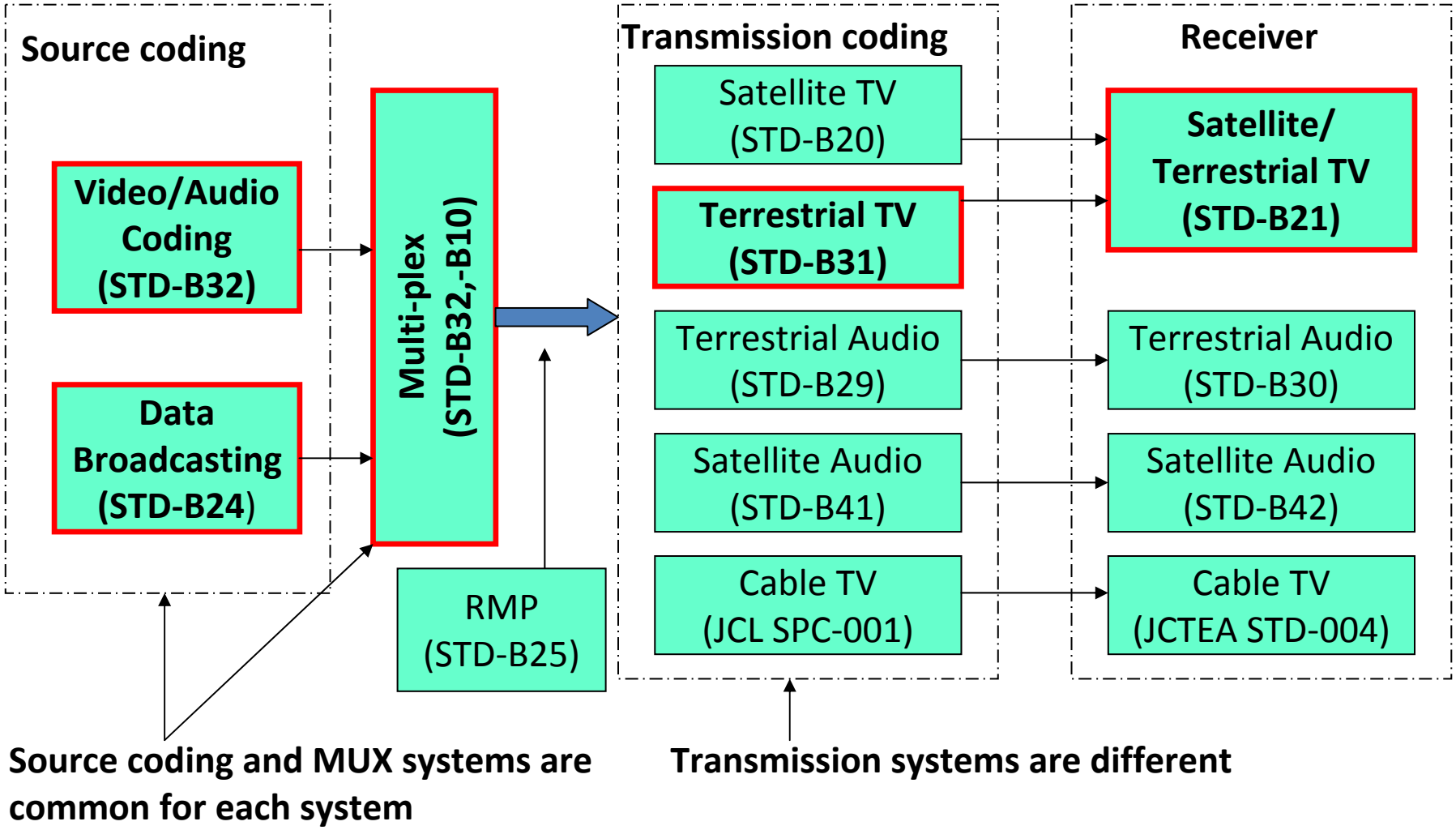
Multiplexed format in ISDB-T system



(note) signal format of PES, TS and Section area is defined in ARIB STD-B32, based on MPEG-2 systems

(note) PSI is defined in both STD-B32 and STD B10. In STD-B32, only outline related to MPEG -2 systems is defined

ARIB standard structure



Note: Cable transmission system standards are defined at another consortium

4. ISDB-T Transmission System

The most important features of ISDB-T is its transmission system, these are “Segmented OFDM transmission” and “Time interleave”. In this section, both outline of ISDB-T transmission system and its features are introduced

4.1 Advantages of ISDB-T transmission system

4.2 What is Segmented OFDM transmission and its merits?

4.3 Structure of ISDB-T transmission system

4.4 Time Interleave

4.5 Service Example

(reference) Transmission Parameter of ISDB-T

4.1 Advantages of ISDB-T Transmission System

(1) Robustness/ reception flexibility

To give the robustness against such degradation factor, ISDB-T adopts OFDM transmission system with “Time Interleave” technology.

As a result, ISDB-T gives following features compare to other DTTB systems;

(a) lower transmitter power,

(b) possibility of indoor antenna reception,

(c)mobile/portable reception service, etc.

(2) Effective utilization of frequency resource

By adopting OFDM transmission system, it is possible to construct Single Frequency Network(SFN). As a result, possible to reduce frequency resource for relay transmitter(repeater).

Further more, using same frequency for plural transmitters of same network, mobile/ portable receiver is not required to change receiving channel.

(3) Mobility/ Portability

To enable fixed/ mobile/portable reception service in same channel, ISDB-T developed new transmission technology, named “Segmented OFDM transmission system”.

As a result, fixed/mobile & portable service in same channel is possible.

“One-seg” service, its unique portable service of ISDB-T, uses 1 segment of 6MHz.

One seg receiver is easily mounted into mobile-phone, portable PDA, USB tuner ,etc, so it enable the broadcast service of “Any time, Any place”

(4) One-seg service

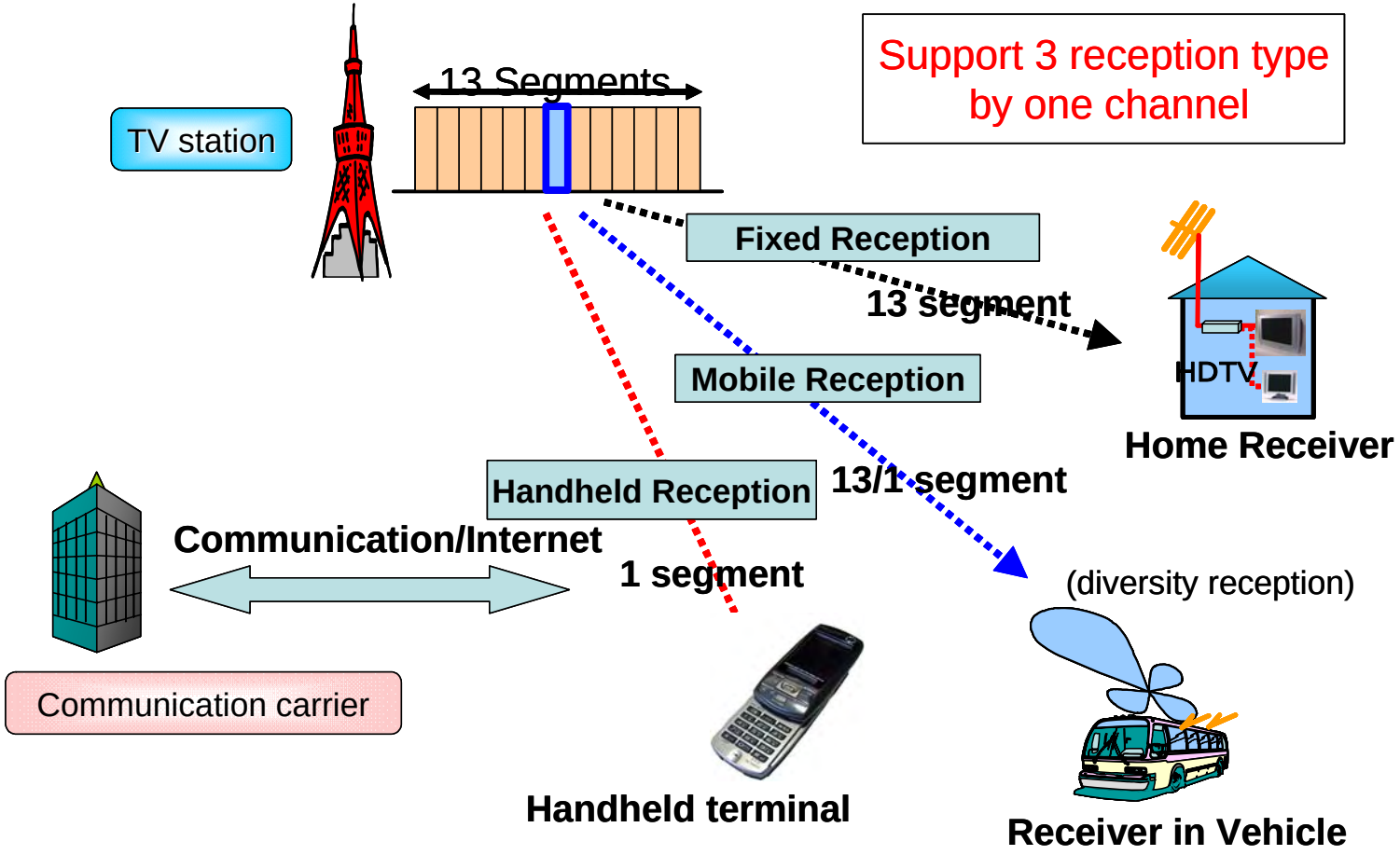
One-seg service, uses 1 segment of 6MHz, dose not need another channel , so not need more transmitter.. it leads save of frequency resource and broadcaster’s infrastructure cost.

And more, One-seg receiver operates as narrow band reception, this operation saves consumption power. As a result, long time reception is possible by battery.

4.2 What is Segmented OFDM?(1/4)

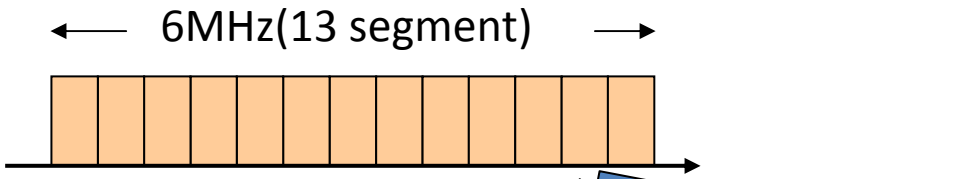
- **Purpose**

To enable multi reception service within same band.

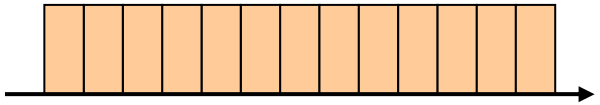


4.2 What is Segmented OFDM?(2/4)

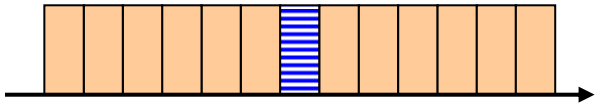
- Hierarchical transmission



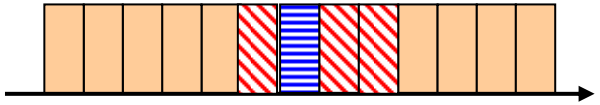
Examples



1 Layer; Fixed only
(multi-TV program)



2 Layer; Fixed + Portable
(HDTV + One-seg)



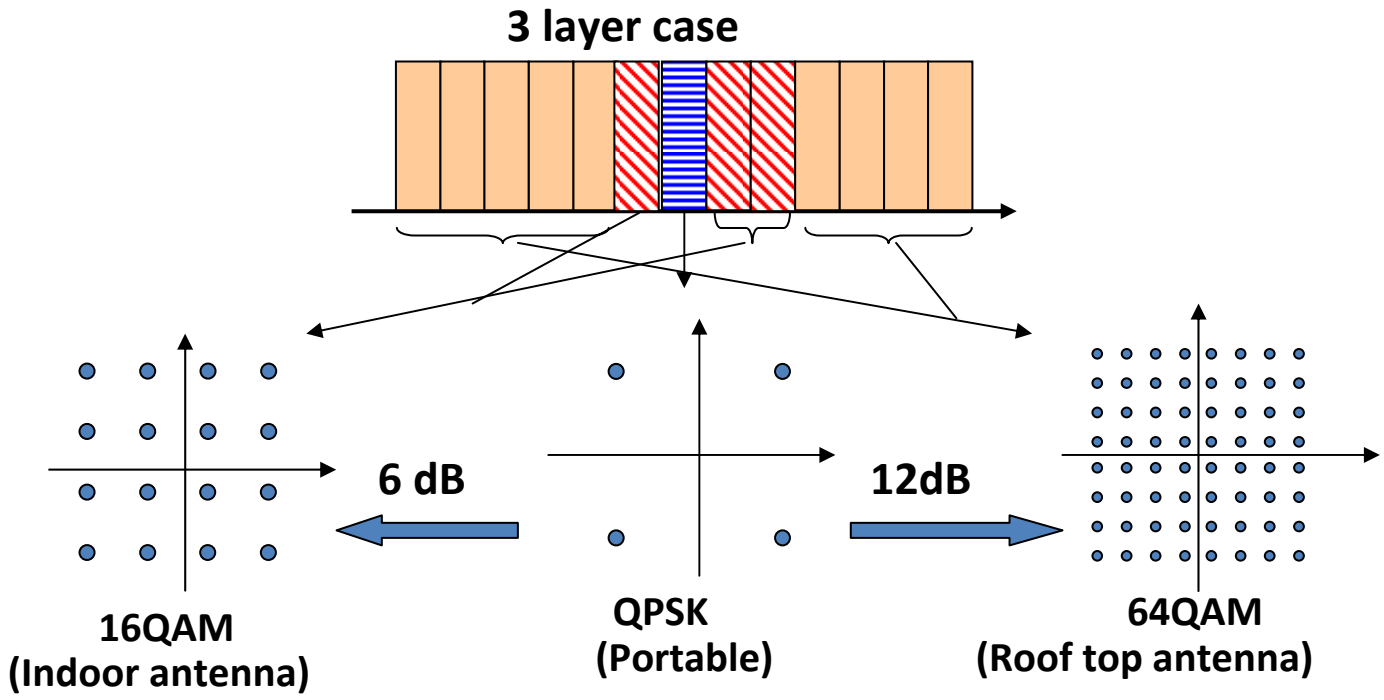
3 Layer; roof top + indoor +portable
(HDTV +SDTV ;One-seg)

Rule

- **No. of layer ;up to 3**
- **No. of segment in each layer; flexible**
- **Transmission parameters of each layer; independently setting**

4.2 What is Segmented OFDM?(3/4)

- Hierarchical transmission

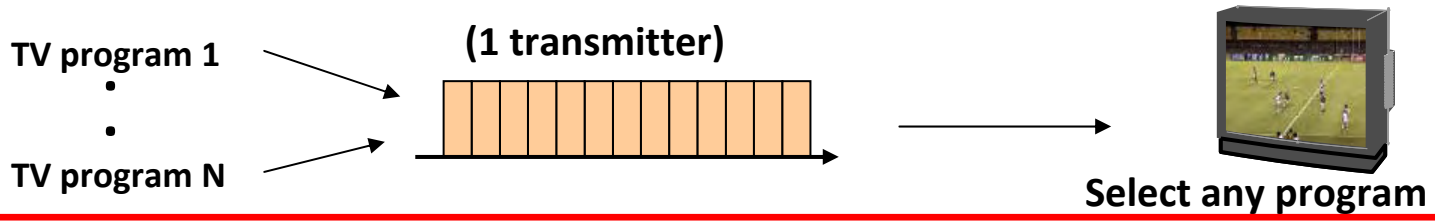


As shown above, ISDB-T transmission system supports maximally 3 reception style.
Therefore, any of transmission system can be arranged according to the service concept **in one frequency channel and one transmitter**

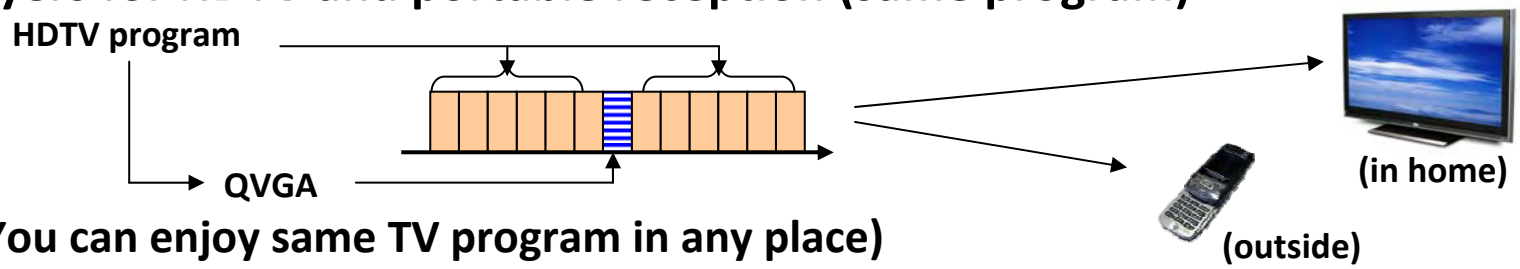
4.2 What is Segmented OFDM?(4/4)

Examples of Broadcasting service by using Hierarchical transmission

(1) Single layer multi-program for stationary reception

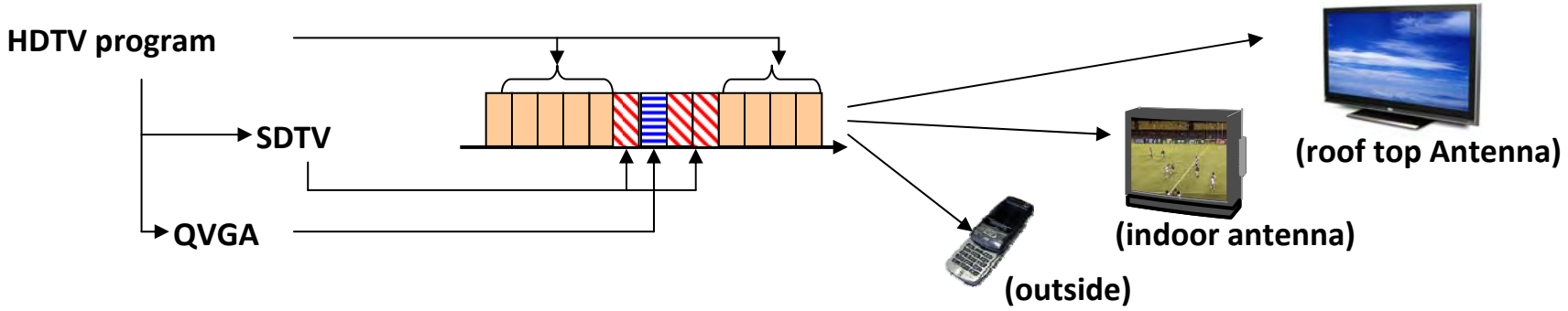


(2) 2 layers for HDTV and portable reception (same program)



(You can enjoy same TV program in any place)

(3) 3 layers for HDTV , SDTV and portable reception (same program)

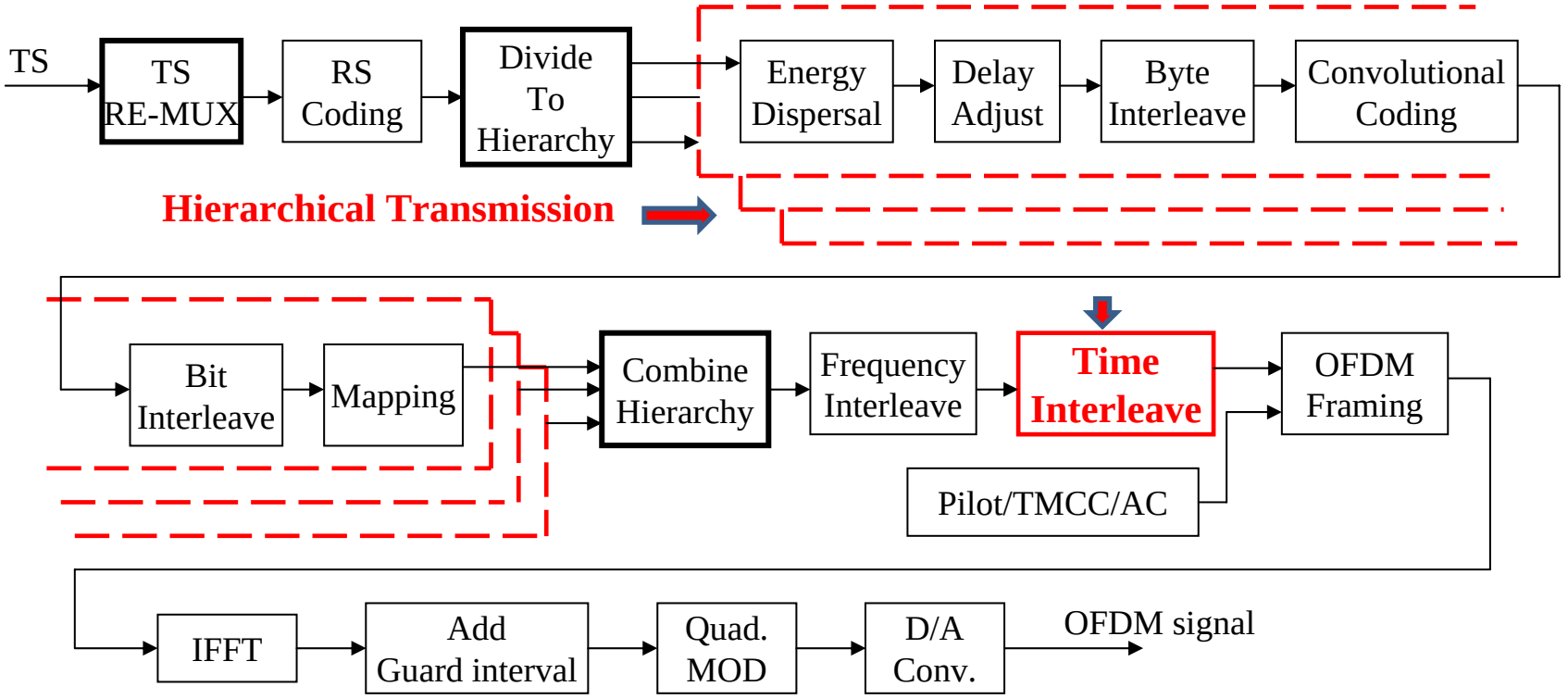


4.3 Structure of ISDB-T transmission System

Features of ISDB-T system are indicated by red color

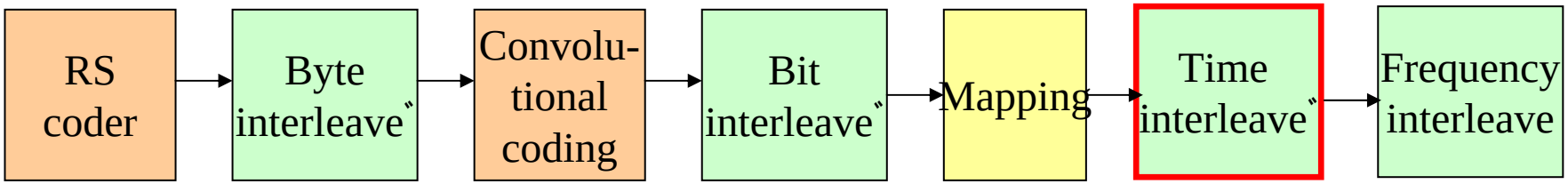
(1)Hierarchical Transmission

(2)Time Interleave



4.4 Time Interleave

4 kinds of interleave are adopted in ISDB-T system



Byte interleave: Effective for burst error correction after Viterbi decoding

Byte interleave is located between outer coder and inner coder. Randomize the burst error of Viterbi decoder output

Bit interleave: Effective for symbol error correction

Bit interleave is located between convolutional coding and mapping. Randomize the symbol error before Viterbi decoding

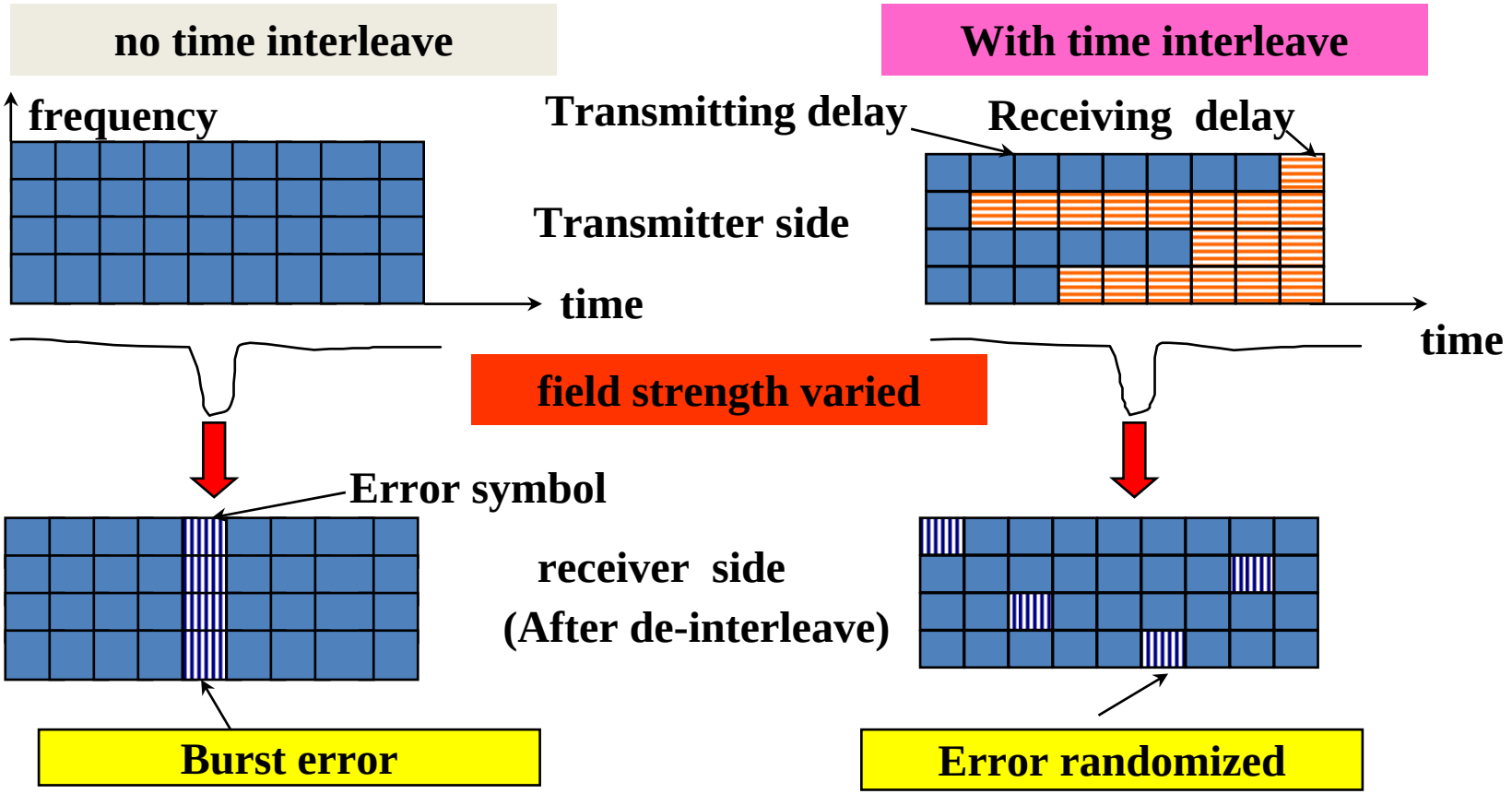
Time interleave: Effective for fading and impulse noise degradation

Time interleave is located at the output of mapping(modulation). And randomize the burst error of time domain which is mainly caused by impulse noise, fading of mobile reception, etc.

Frequency interleave: Effective for multi-path distortion degradation

Frequency interleave is located at the output of time interleave. Randomize the burst error of frequency domain which is mainly caused by multi-path , carrier interference, etc.

Effect of Time Interleave

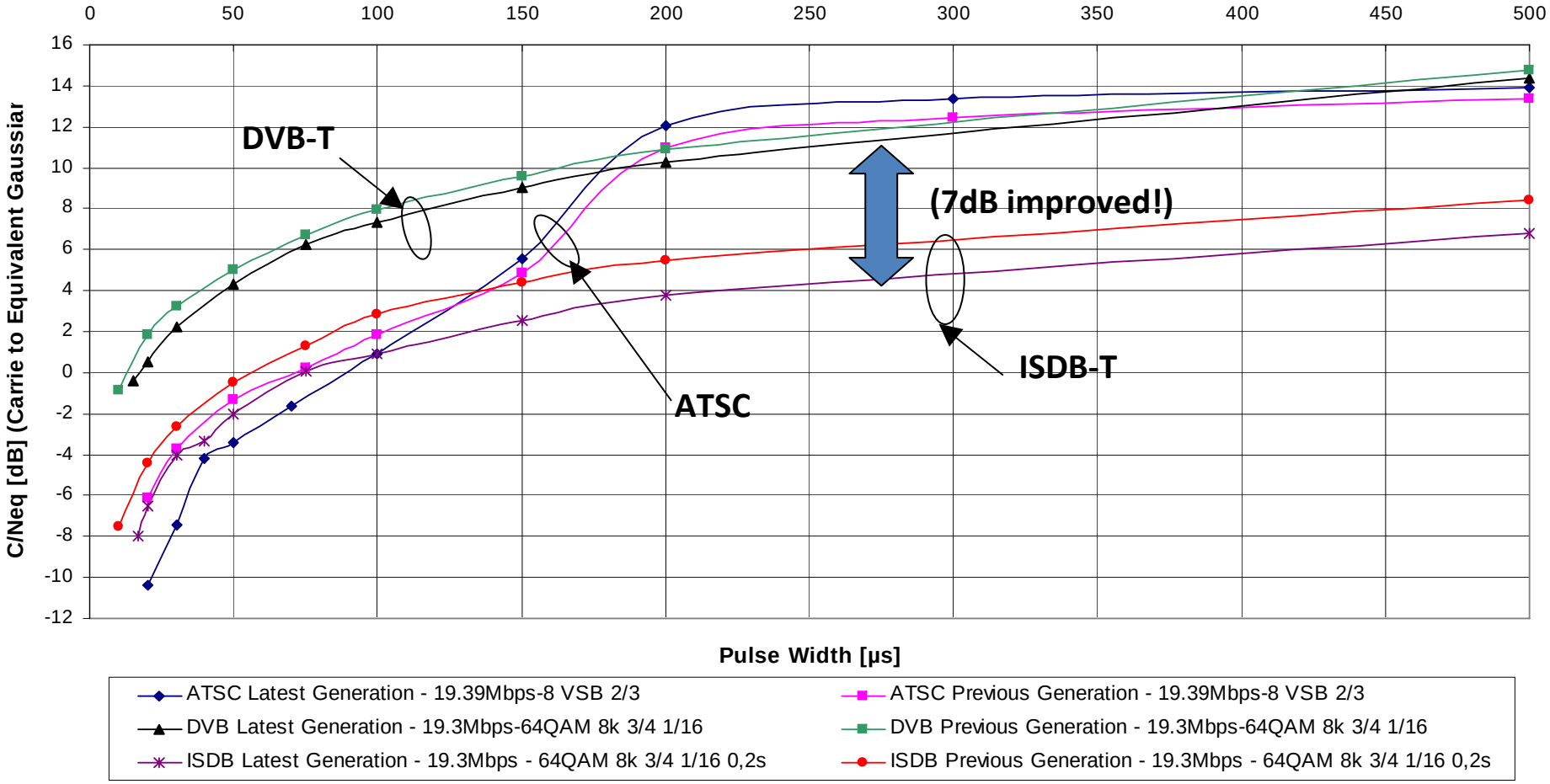


Time Interleave is effective not only for signal level fluctuation but also for impulse interference

What is the merit of Time- Interleave?

- **How much improved by using Time- Interleave**

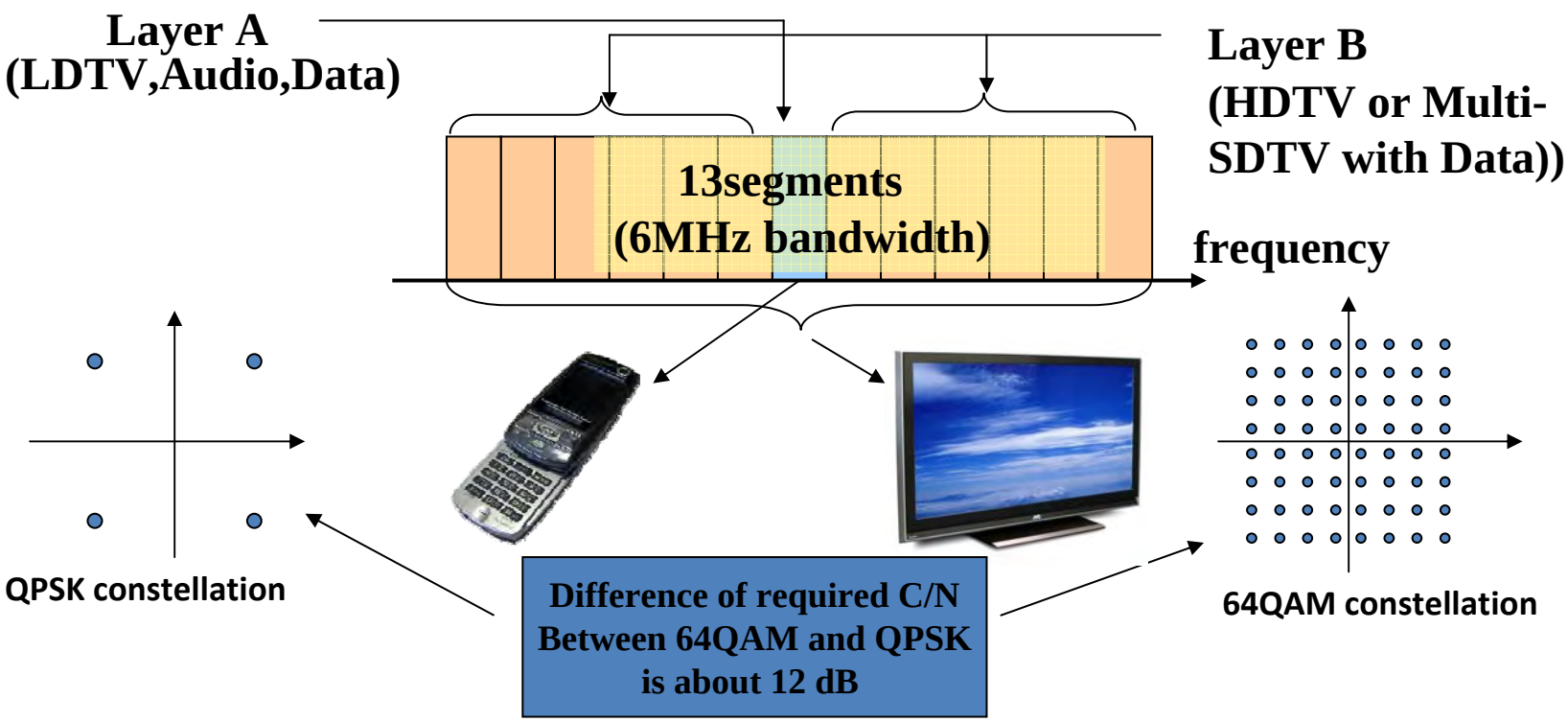
Following graph shows degradation by impulse noise, which is dedicated by Mackenzie Presbyterian University measured in Autumn , 2005



7dB improved ⟹ Transmitter power reduced to 1/5 !!

4.5 Service example: ISDB-T Hierarchical service in Japan (HDTV + One-seg service)

(Example; 1seg + 12 seg)



*13 segments are divided into layers, maximum number of layers is 3.

*Any number of segment for each layers can be selected (totally 13 segment)

*Transmission parameter sets of each layer can be set independently
(In above example, modulation index of each layer are different)

(reference)

Transmission 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	252μs	504μs	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. Differences of 3 DTTB systems

5.1 What are the difference?

The difference of 3 DTTB systems should mainly depends on the difference of Transmission system

Table 5-1 Transmission system

System		ATSC	DVB-T	ISDB-T
Modulation		8VSB	**COFDM** (QPSK, 16QAM,64QAM)	**SegmentedCOFDM** (DQPSK,QPSK, 16QAM,64QAM)
Inter-leaving	Bit/Symbol	Yes	Yes	Yes
	Frequency	-	Yes	Yes
	time	-	-	**0.1s,0.2s,0.4s,0.8s**
Excess Bandwidth/ Guard Interval		11.5%	1/4,1/8,1/16,1/32	1/2, 1/4, 1/8,1/16,1/32
TMCC		-	-	**Yes**
Information bit rate		19.39 Mbps	3.69 -23.5Mbps	3.65 -23.2 Mbps
Channel bandwidth		6/7/8 MHz	6/7/8 MHz	6/7/8 MHz

5.2 Summary of Comparison from Technical Aspect

Based on the differences of transmission system, show the difference of system performances in Comparison table below

Table 5-2 Comparison of system performances

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	**(note1)** **ISDB-T** >> DVB-T
Robustness against impulse noise	**ISDB-T**
Wide area single frequency network (SFN) operation	DVB-T, **ISDB-T**
Mobility and Portability	**ISDB-T>** DVB-T

(note1) Indoor reception can be available, its reduce reception cost

5.2 Summary of Comparison from Technical Aspect-2/2

Table 5-2 Comparison of system performances

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

Requirements	System conform to requirements
Hierarchical transmission (Multiple modulation systems simultaneously in the same channel is possible)	**ISDB-T**>> DVB-T
Both portable/fixed reception service by one channel and one transmitter	**ISDB-T**(note1)
System commonality with digital terrestrial sound broadcasting (One segment receiver is available)	**ISDB-T**(note2)

(note1) Save both frequency resource and Infrastructure cost

(note2) Multi purpose portable receiver is available

5.3 Receiver structure

Figure 5-1. shows the Simplified Block diagram of Digital Terrestrial Receiver.

(1) Tuner block: mainly specified not by system, but by regulation of each countries

(2) Demodulator block: mainly specified by each transmission system

(3) Backend block: mainly specified not by transmission system, but by Service Quality/Performances

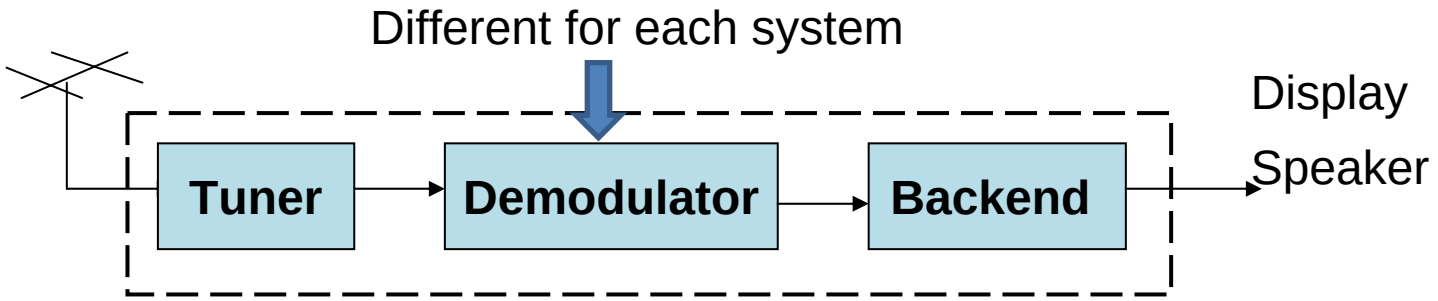


Figure 5-1. Simplified block diagram of receiver

Conclusion: As shown above, the most important parameters for receiver cost is not the difference of system, but service Quality/ Performances.

5.4 Transmitter structure

Figure 5-2 , below, shows the Block diagram of 3 DTTB comparison test system in Chile, 2007.

As shown in figure 5-2, Main difference of each systems is only modulator portion. Therefore, the difference of system does not so affect for equipment cost. The dominant parameters for equipment cost are Output power, performances ,composition, etc.

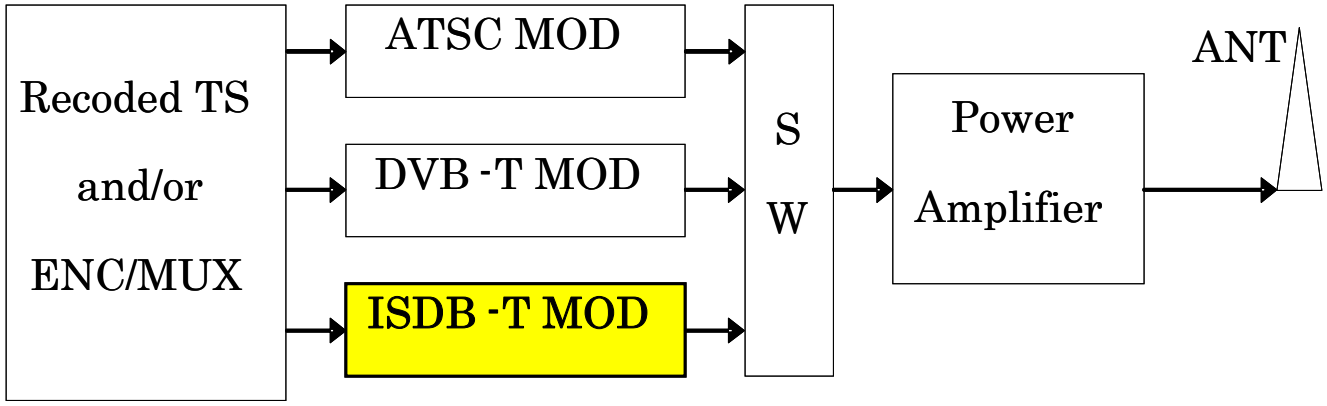


Figure 5-2. Block diagram of 3 DTTB system comparison test in Chile

5.5 Difference of system cost

As described before, both receiver and transmitter hardware cost are not so different for each system.

But, system cost for each system are quite different for following cases:

Case 1: Both fixed/portable reception service

ISDB-T is the only one system to **enable both service by one transmitter and one frequency.** In addition, only **one transmission network** is necessary for ISDB-T system. On the other hand, DVB system requires different network for fixed and handheld reception service.

Case 2: Indoor reception service

As described before, ISDB-T shows the best performances in impulse noise condition(7dB lower), it means that **ISDB-T saves transmitter power** to 1/5 compared to other system in same indoor reception condition.

→ **ISDB-T is the most economical system**

6. Examples of comparison test

Forward

Comparison test was/has been/is done in some countries for getting the technical base and system design of DTTB system.

We will introduce some examples as a reference.

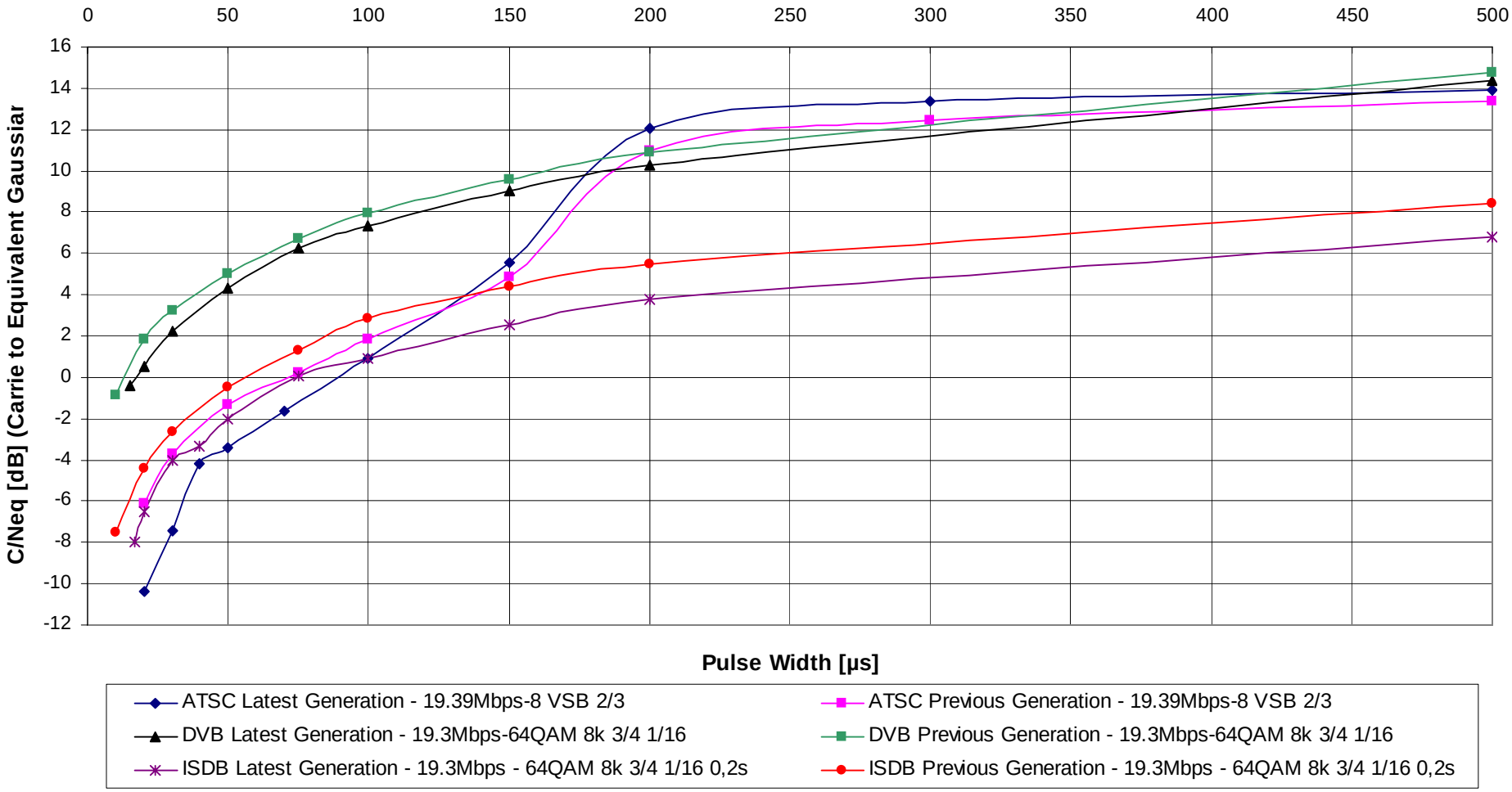
6.1 Example of Laboratory Test

This test was done in October,2005 by Mackenzie University in Brazil, the purpose of this test was to compare/ evaluate each system under critical condition. As an example, show the reception performance under impulse noise condition in next page.

(note) This test was finished before Brazilian decision

Laboratory test results

Impulse Noise pulse rate=100Hz



6.2 Example of Field Test

(1) 3 DTTB Systems Comparison Test in Brazil in 2000

This test was done by Broadcast engineers and members of Academia. The purpose of this test was to investigate the best system for Brazil on fair position.

(2) Field Test in Chile in 2007

This test was done in 2007 for evaluating the performances of each systems.

This test was mainly done for fixed reception performances, both outdoor antenna and indoor antenna.

(3) Field Test in Peru in 2007 -2008

Peru is now on testing of 3 DTTB systems for various point of view.

Such as, (a)Place(Capital city, Amazon, Andes), Reception style (outdoor, indoor, mobile).

As explained in previous presentation 2, all these test results indicate the priority of ISDB-T, especially indoor, mobile/ portable reception

7. ISDB-T receivers in Japanese market

■Fixed Receivers

PDP TV

VIERA TH-42PZ700SK
Panasonic

Wooo P42-HR01
HITACHI

PDP-A427HX
Pioneer

LCD TV

REGZA 42H3000
TOSHIBA

AQUOS LC-42RX1W
SHARP

VIERA TH-20LX70
Panasonic

BRAVIA KDL-40V2500
SONY

LCD-32HR100
SANYO

AQUOS LC-16E1
SHARP

SDTV

VIERA TH-15LD70
Panasonic

AQUOS LC-13SX7
SHARP

■Fixed Receivers(Cont.)

HDD/DVD Recorder

RDZ-D800
SONY

DIGA DMR-XW51
Panasonic

VARDIA RD-S600
TOSHIBA

DVR-DV635
MITSUBISHI

Blu-ray

BDZ-V9
SONY

DIGA DMR-BW200
Panasonic

STB

TU-MHD600
Panasonic

DT400
MASPRO

Cable STB

TZ-DCH1800
Panasonic

For low cost STB, Please listen and watch next presentation!

■Fixed Receivers(Cont.)

Desktop PC

20 inch
(1680x1050)

VALUESTAR S VS770/JG

NEC

20.1 inch
(1680x1050)

FMV-DESKPOWER LX70W/D

FUJITSU

20.1 inch
(1680x1050)

Prius One type W AW37W5U

HITACHI

Notebook PC (medium-large size)

15.4 inch
(1280x800)

LaVie L LL970/HG

NEC

17 inch
(1440x900)

FMV-BIBLO NX95W/D

FUJITSU

17 inch
(1920x1200)

Qosmio G40/95C

TOSHIBA

■In-car Receivers

Navigation System
Full-Seg/One-Seg

Tuner separated model

Strada CN-HDS965TD

Panasonic

AVIC-VH099G

Pioneer

All-in-one model

HS706D-A

NISSAN/SANYO

One-Seg Only

※Full-Seg is Optional

GORILLA NV-HD830DT

SANYO

Portable Navigation Device
One-Seg Only

Mini GORILLA
NV-SD10DT

SANYO

In-Car TV
One-Seg Only

CAV-TD85D1

SANYO

■Portable Receivers

Cell Phone　One-Seg Only

W51SA

P903iTV

911SH

W52T

D903iTV

911T

au

14 models are available
at the end of May, 2007

NTT DoCoMo

4 models are available
at the end of May, 2007

Softbank

3 models are available
at the end of May, 2007

■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

8. Examples of ISDB-T Transmitter

(1) High power digital transmitter (Toshiba)

(a) Frequency band: UHF

(b) Output power: 15 kW
(7.5 kW × 2)

(c) Cooling system: water

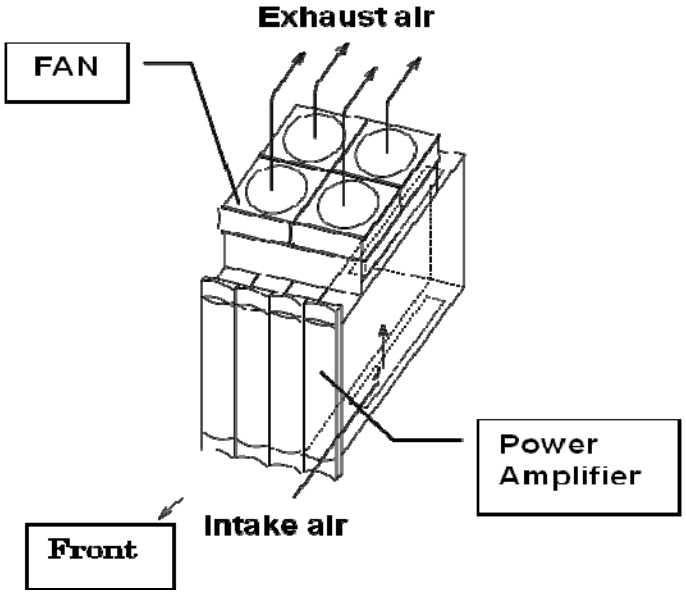
(2) Middle power digital transmitter(Toshiba)

(a) Frequency band: UHF

(b) Output power range: see table below

Model	Number of PA	Output power (Max)	Dimensions			
			Weight* (kg)	Width (mm)	Depth (mm)	Height (mm)
TDU8024F#X	2	0.5kW	325	570	800	1900
TDU8034F#X	3	0.8kW	350			
TDU8044F#X	4	1.0kW	380			

(c) Cooling system: air



9. Others

9.1 IPR Policy for ISDB-T system

ARIB announced to other countries which are considering to adopt ISDB-T system .

COMMITMENT ON THE INDUSTRIAL PROPERTY RIGHTS

Attached to this letter is the list of patents which are reported to ARIB and the reporter considers that the listed patents are essential to ARIB Standards B10, B21, B24 and/or B31. The attached list also contains countries of application for each patent. There are no patents that are applied or granted with regard to Argentina in the list. Therefore, as far as ARIB knows, ARIB thinks that no payments will be due by the essential patents in Argentina.

➡ For Philippines, same policy will be adopted

ARIB

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November 10, 2008

Sr. Carlos Lisandro SALAS
Secretary of Communications
Government of Argentine Republic

Dear Sr. Carlos Lisandro SALAS,

I am pleased to advise you of the following commitment on the industrial property rights offered by the Japanese side, which will be valid in case the Government of Argentina selects ISDB-T as the Argentine standard for digital television.

COMMITMENT ON THE INDUSTRIAL PROPERTY RIGHTS

Attached to this letter is the list of patents which are reported to ARIB and the reporter considers that the listed patents are essential to ARIB Standards B10, B21, B24 and/or B31. The attached list also contains countries of application for each patent. There are no patents that are applied or granted with regard to Argentina in the list. Therefore, as far as ARIB knows, ARIB thinks that no payments will be due by the essential patents in Argentina.

Sincerely yours,

高橋泰雄

Yasuo Takahashi
Chairperson
Digital Broadcasting Experts Group

An example of ARIB letter for IPR policy

9.2 About DVB-T2

(a)What is DVB-T2? How about the compatibility with DVB-T?

(1) Purpose: extend payload, improve required C/N

(2) Relation between DVB-T**: DVB-T2 is not designed to replace DVB-T; rather the two standards will coexist in many markets for many years**.(quoted from DVB fact sheet)

	DVB-T	DVB-T2
FEC	Convolutional Coding + Reed Solomon 1/2, 2/3, 3/4, 5/6, 7/8	LPDC + BCH 1/2, 3/5, 2/3, 3/4, 4/5, 5/6
Modes	QPSK, 16QAM, 64QAM	QPSK, 16QAM, 64QAM, 256QAM
Guard Interval	1/4, 1/8, 1/16, 1/32	1/4, 19/256, 1/8, 19/128, 1/16, 1/32, 1/128
FFT size	2k, 8k	1k, 2k, 4k, 8k, 16k, 32k
Scattered Pilots	8% of total	1%, 2%, 4%, 8% of total
Continual Pilots	2.6% of total	0.35% of total

Described in above table, DVB-T2 adopts quite different transmission system from DVB-T.

→ **DVB-T2 has no compatibility with DVB-T system**

(b) How about the schedule?

(1) Standardization: The DVB-T2 specification was approved by the DVB Steering Board at the end of June 2008.

(2) First prototype: ?

(3)Commercial model: ? (which countries ? The first country to deploy DVB-T2 **is likely to be** the UK)

→ When commercial type DVB-T2 receiver will be provided? And How much?

(c) How co-exist (or co-work) with other DVB-T system?

(1) Australia has already started HDTV service in 7 MHz DVB-T.

(2) France is now considering to shift to HDTV by MPEG-4

→ How co-exist or harmonize the service/hardware?

10. Conclusion

- **ISDB-T was born from high level requirement**

  -High quality/service flexibility, Robustness, Resource saving, etc

- **ISDB-T Transmission system**

  -Segmented OFDM Transmission System, It enable hierarchical transmission service, stable mobile/portable reception and indoor reception

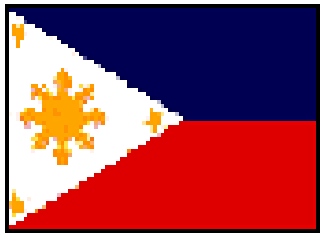
- **One-seg is the unique and attractive service of ISDB-T**

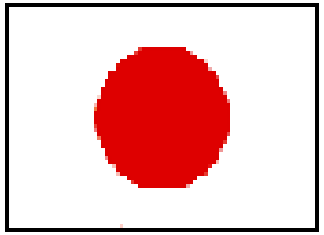
- **Receiver and transmitter structure is not so different**

  -the difference of hardware cost is affected from Quality/ Performances , not affected from system difference

- **But, ISDB-T is the most economical system**

  -Save both frequency and transmitter for fixed/portable reception service, and show best performances under urban noise condition.





Thank you for your attention !

Salamat po!

Yasuo TAKAHASHI

ARIB-DiBEG

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