Presentation 2

Technical Aspect of ISDB-T system and Hardware

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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)

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What's ISDB-T ?

-ISDB-T is

-Requirements/Solutions

-ISDB family

-Technical solutions

-Parameters of ISDB-T system

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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

ISDB-T Demo

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Market Requirements for ISDB-T

- HDTV and Multi SDTV
- Multimedia Service
- Mobility and Portability
- Flexible/Versatile
- Data Broadcasting
- Effective Spectrum Utilization
- Commonality of Receiver

Requiremens for Digitization→Solutions

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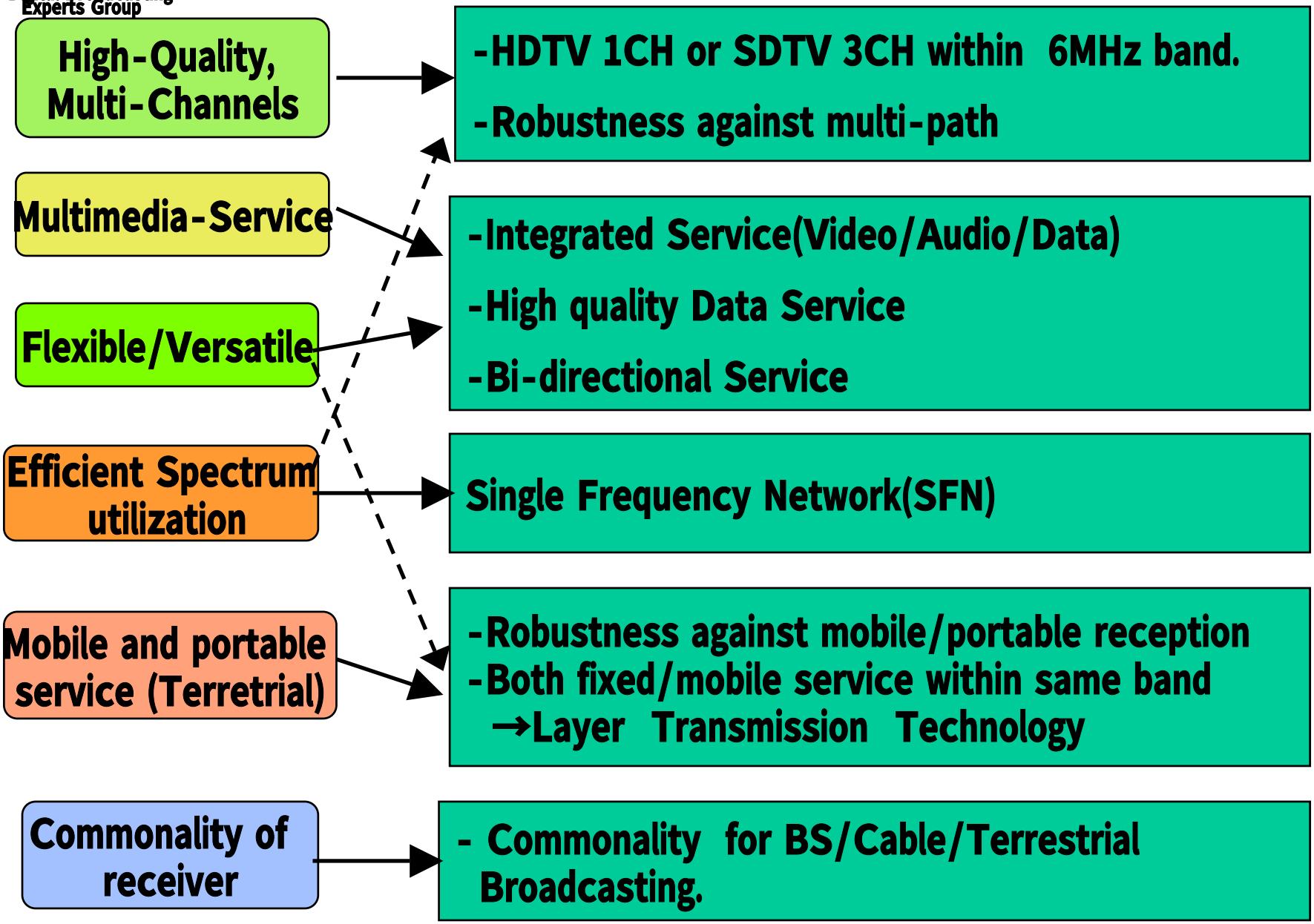

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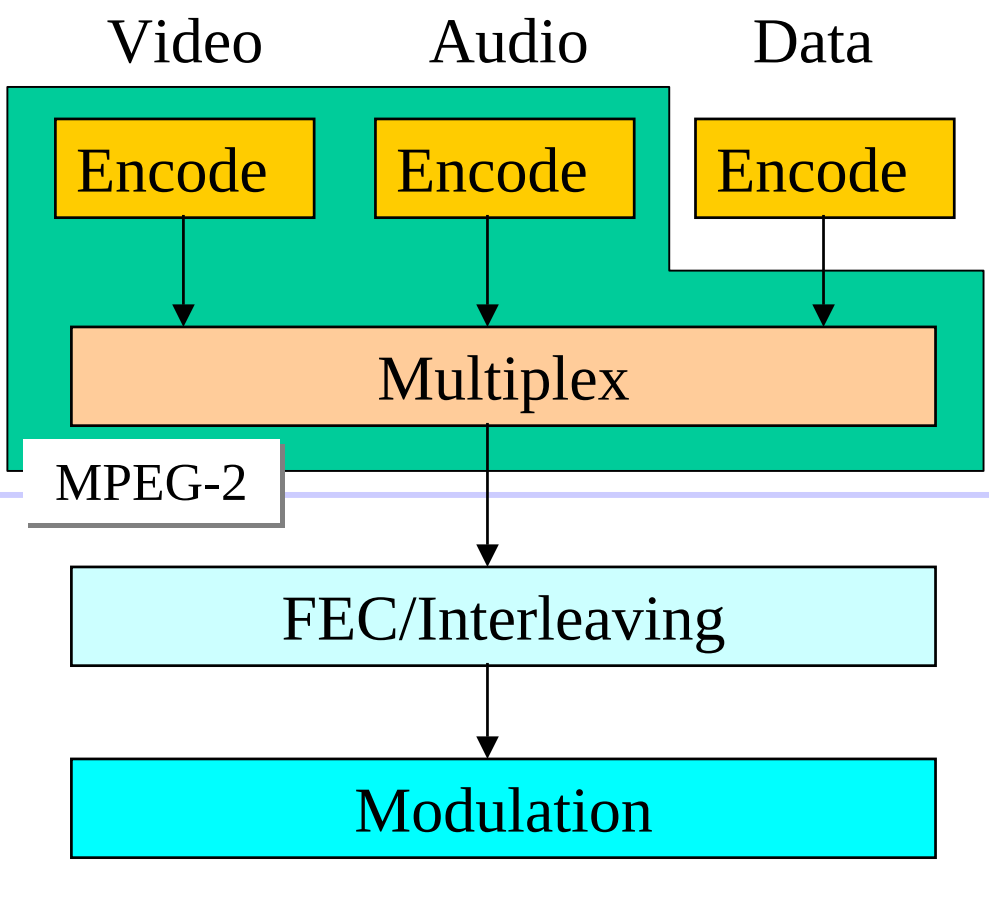
Layered Structure for Digital Broadcasting



Application Layer
Commonality
Interoperability
↓
MPEG-2 Standard

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

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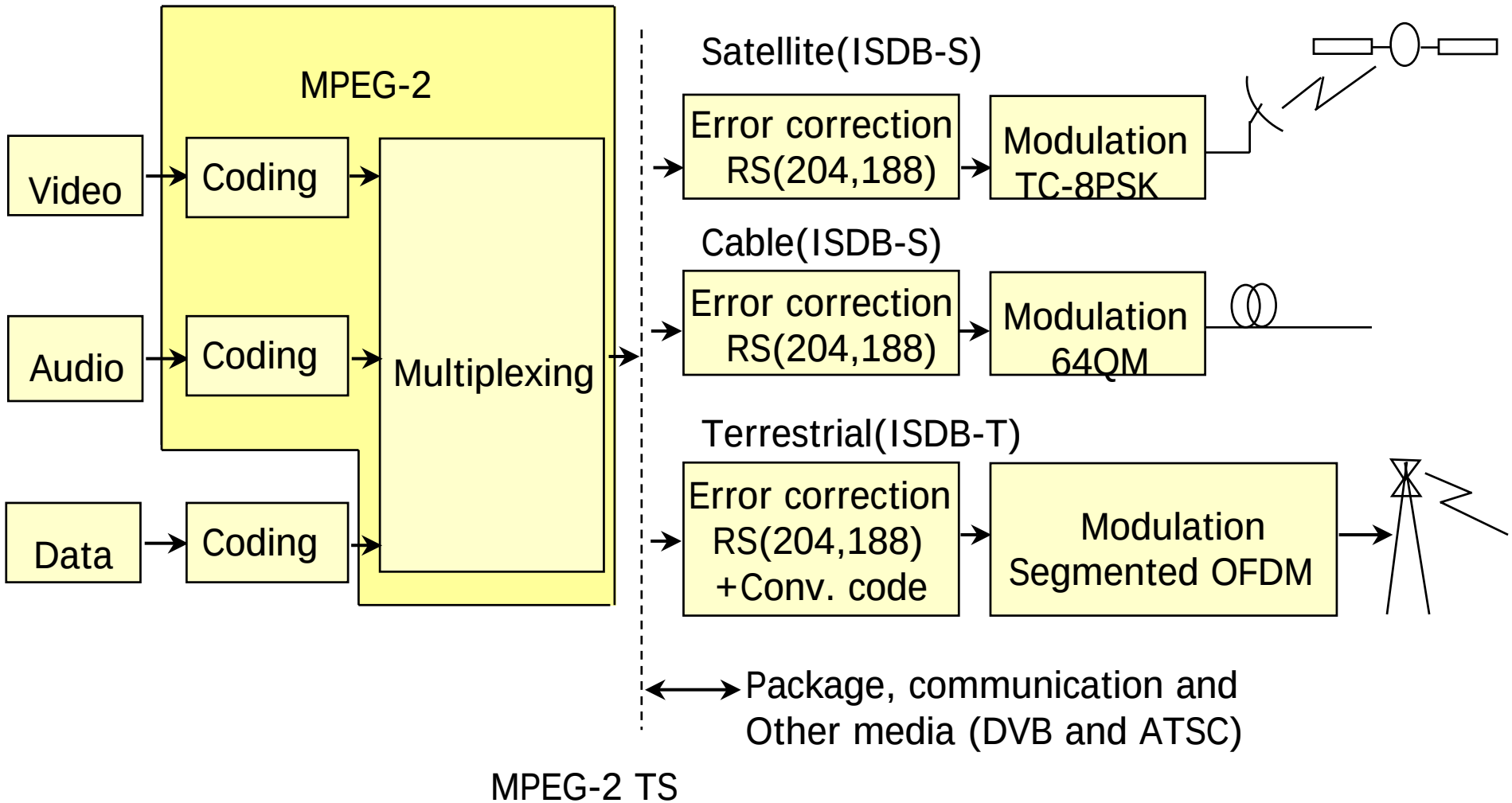
ISDB Family



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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

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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

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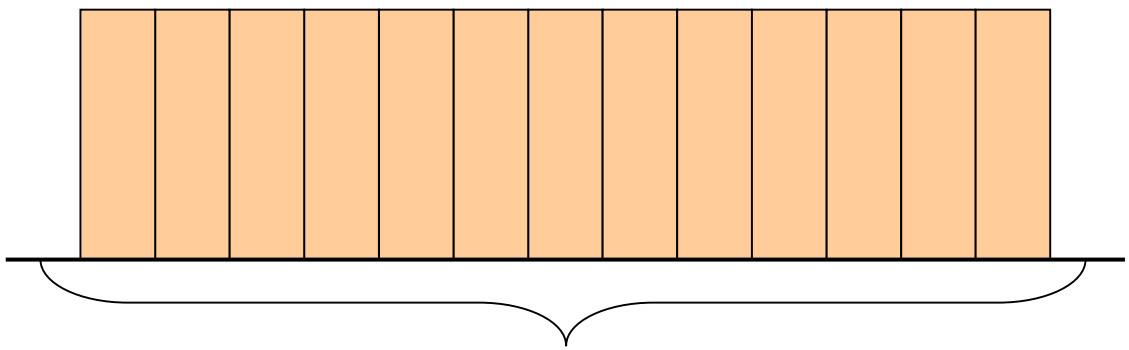
Segmented Structure and Partial Reception



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

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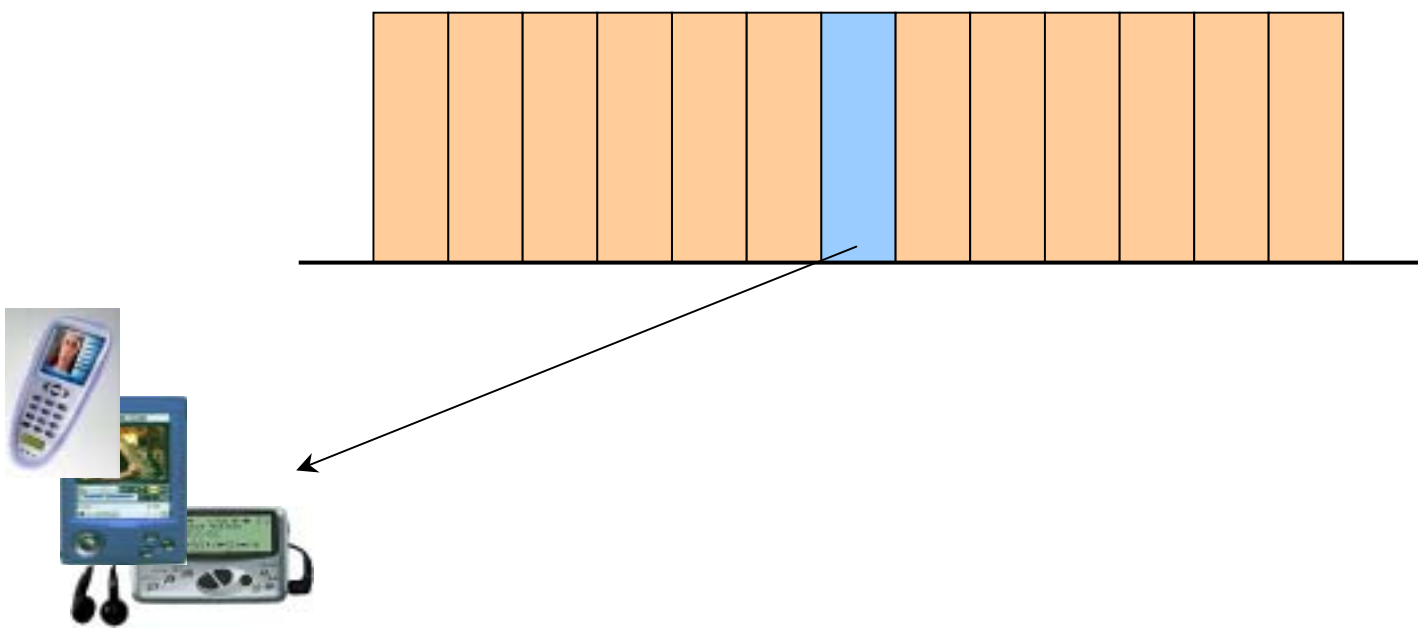
Segmented Structure and Partial Reception



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Transmission Scheme

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  - 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

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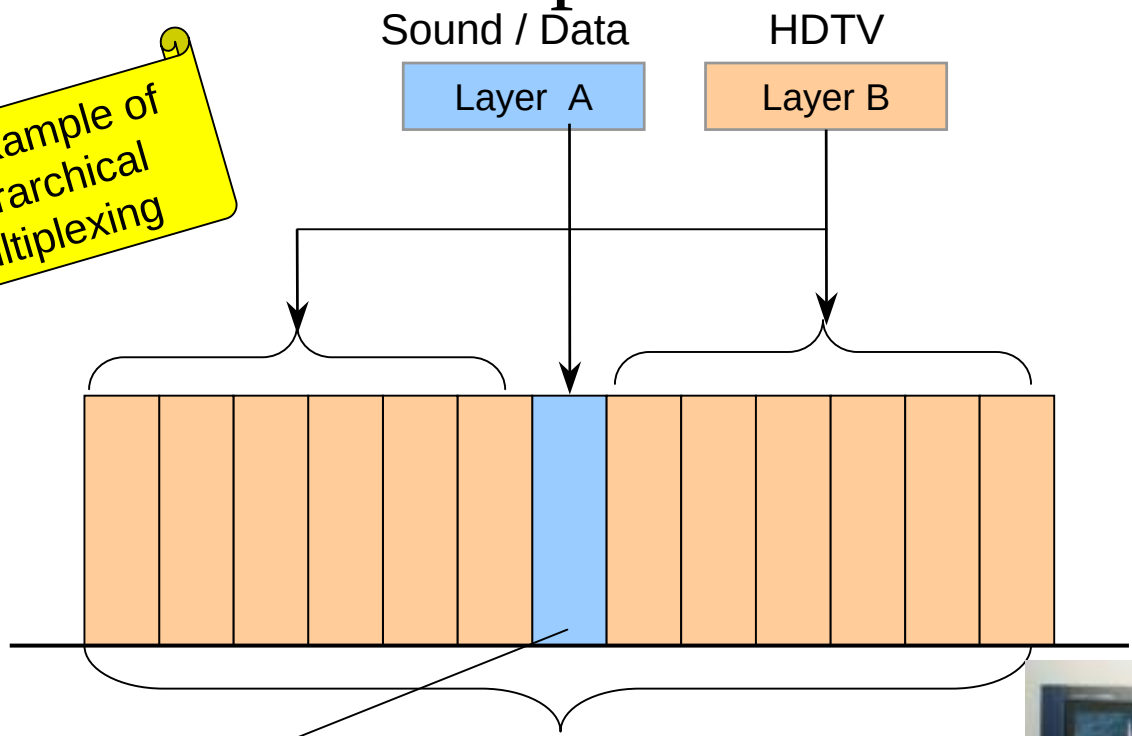
Segmented Structure and Partial Reception

An Example of Hierarchical Multiplexing



Parameter	64QAM 3/4 12 segments	16QAM 1/2 1 segment
Bit rate	16.9 Mbps	630 kbps

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Three Mode of ISDB-T

	Mode1(2K)	Mode2(4K)	Mode3(8K)
DQPSK	Mobile SDTV	Mobile & Fixed HDTV/SDTV	Fixed HDTV/SDTV
QPSK			
16QAM			
64QAM			

TMCC can change the mode any time to any combination.

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Parameters of ISDB-T

(6MHz Bandwidth)

ISDB-T Mode	*Mode 1*	*Mode 2*	*Mode 3*
No. of OFDM Segment	13		
Useful Bandwidth	5.575MHz	5.573MHz	5.572MHz
Carrier Spacing	3.968kHz	1.984kHz	0.992kHz
Total Carriers	1405	2809	5617
Modulation	DQPSK, QPSK, 16QAM, 64QAM		
Active Symbol Duration	252 μsec	504 μsec	1,008 μsec
Guard Interval Duration	1/4 , 1/8 , 1/16 , 1/32 of Active Symbol Duration		
No. of Symbols per Frame	204		
Time Interleaving	0, 0.125, 0.25, 0.5sec		
Inner Coding	Convolutional Code (1/2, 2/3, 3/4, 5/6, 7/8)		
Outer Coding	RS(204, 188)		
Useful Bit Rate	3.65Mbps ~ 23.23Mbps		
Hierarchical Transmission	up to Three Layers		

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Parameters of ISDB-T

(8MHz Bandwidth)

ISDB-T Mode	*Mode 1*	*Mode 2*	*Mode 3*
No. of OFDM Segment	13		
Useful Bandwidth	7.434MHz	7.431MHz	7.430MHz
Carrier Spacing	5.291kHz	2.645kHz	1.322kHz
Total Carriers	1405	2809	5617
Modulation	DQPSK, QPSK, 16QAM, 64QAM		
Active Symbol Duration	189 μsec	378 μsec	756 μsec
Guard Interval Duration	1/4 , 1/8 , 1/16 , 1/32 of Active Symbol Duration		
No. of Symbols per Frame	204		
Time Interleaving	0, 0.125, 0.25, 0.5sec		
Inner Coding	Convolutional Code (1/2, 2/3, 3/4, 5/6, 7/8)		
Outer Coding	RS(204, 188)		
Useful Bit Rate	4.87Mbps ~ 30.98Mbps		
Hierarchical Transmission	up to Three Layers		

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DTTV System Selection Guideline

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
Resistivity against multi-path distortion	DVB-T, **ISDB-T**
Resistivity against impulse noise	**ISDB-T**
Wide area single frequency network (SFN) operation	DVB-T, **ISDB-T**
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**

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Why ISDB-T now?

-comparison of 3 DTTV systems
-Results of comparison test in Brazil
-DTTV selection guide
-Conclusion

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Broadcasting Services

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

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Ethernet and Phone connector of ISDB-T TV SET

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Technical Detail of DTTV Systems - 1

System		ATSC	DVB-T	ISDB-T
Launch		1/Nov/1998	Sep/1998	1/Dec/2003
Video coding		MPEG-2 Video(ISO/IEC 13818-2)		
Audio coding		Dolby AC-3	MPEG-2 BC	MPEG-2 AAC
Data broadcasting	Presentation engine	Dase-1	(DVB HTML)	BML (XHTML), ECMAScript
	Execution engine	ACAP	DVB MHP	ARIB B 23
Multiplex		MPEG-2 Systems (ISO/IEC 13818-1)		
Conditional access		DES / NRSS	CSS / DVB CA	Multi 2 / ARIB B 25
Error correction	Outer	(207,187) Reed-Solomon code	(204,188) Reed-Solomon code	
	Inner	2/3Trellis Code	Conv.code(1/2-7/8)	

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Technical Details of DTTV Systems - 2

System		ATSC	DVB-T	ISDB-T
Modulation		8VSB	**COFDM** (QPSK, 16QAM,64QAM)	**Segmented COFDM** (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

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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.

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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)
  - Report on the technical trial of digital terrestrial television(DTT) Digital Terrestrial Television Steering Committee (executive summary)
- 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)

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Result of comparison test conduced by ABERT/SET of Brazil

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

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Laboratory Tests Basic Configurations

	ATSC	DVB-2K*	DVB-8K**	ISDB-4K***
PAYLOAD (Mbps)	19.39	19.75	18.09	19.33
Configurations	1	Many		Lots

* 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

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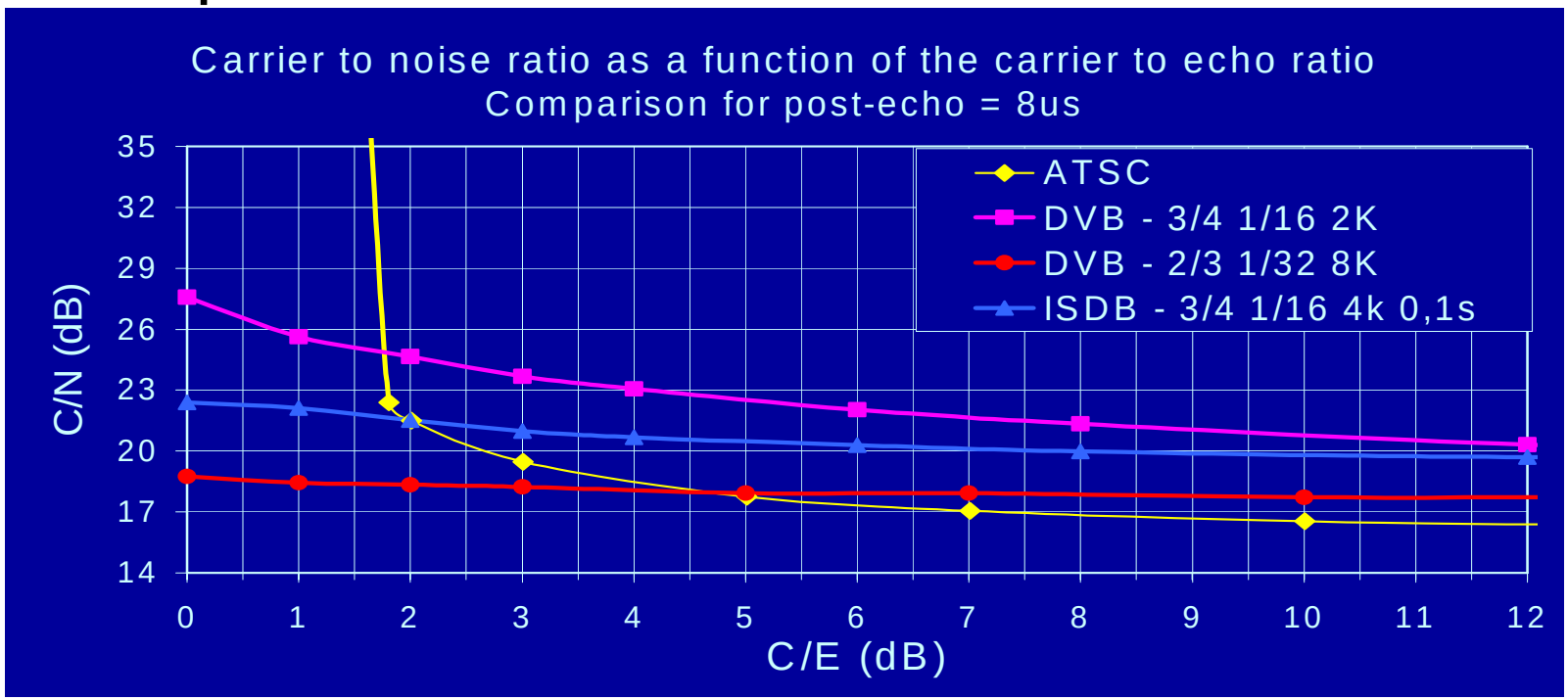
Laboratory Tests - Results

- Multi-path



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

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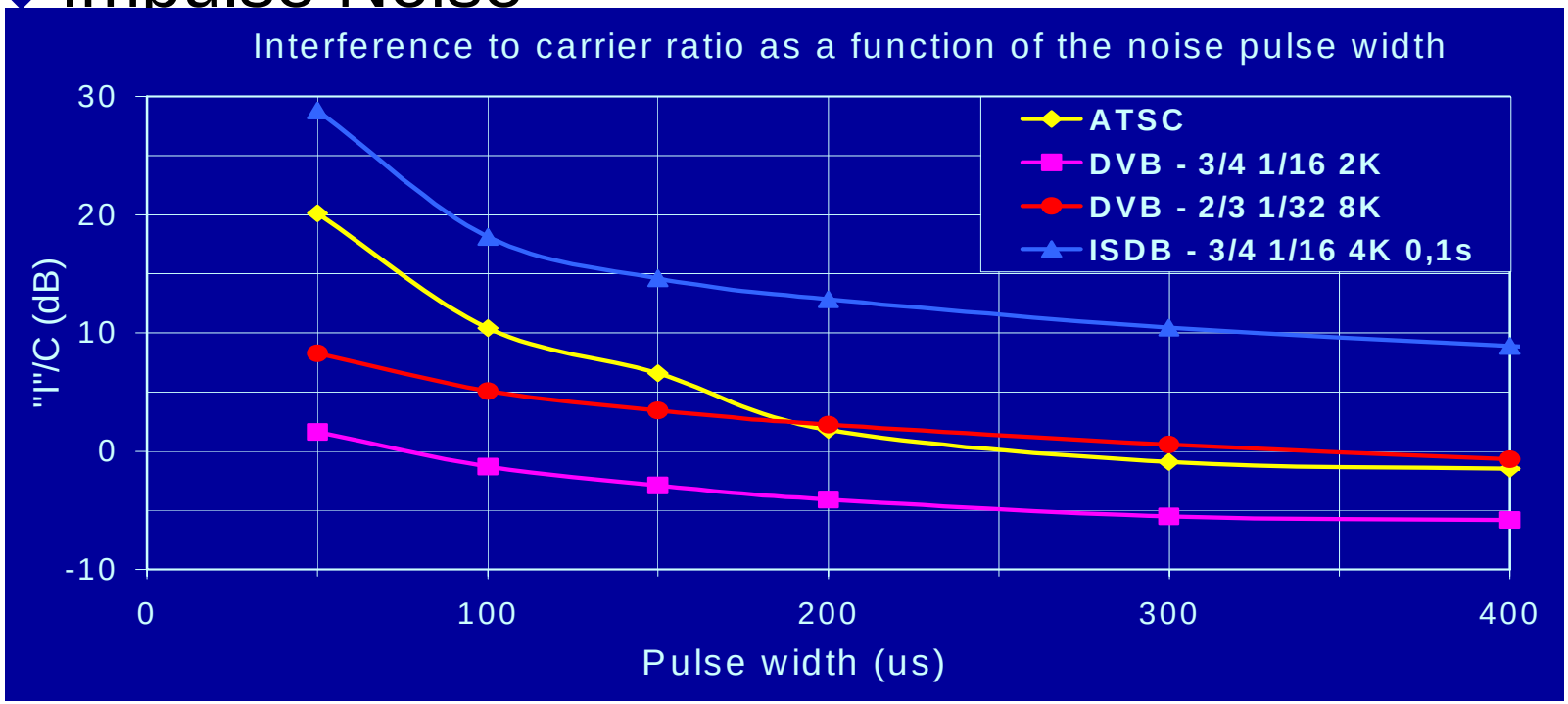
Laboratory Tests - Results

- Impulse Noise



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

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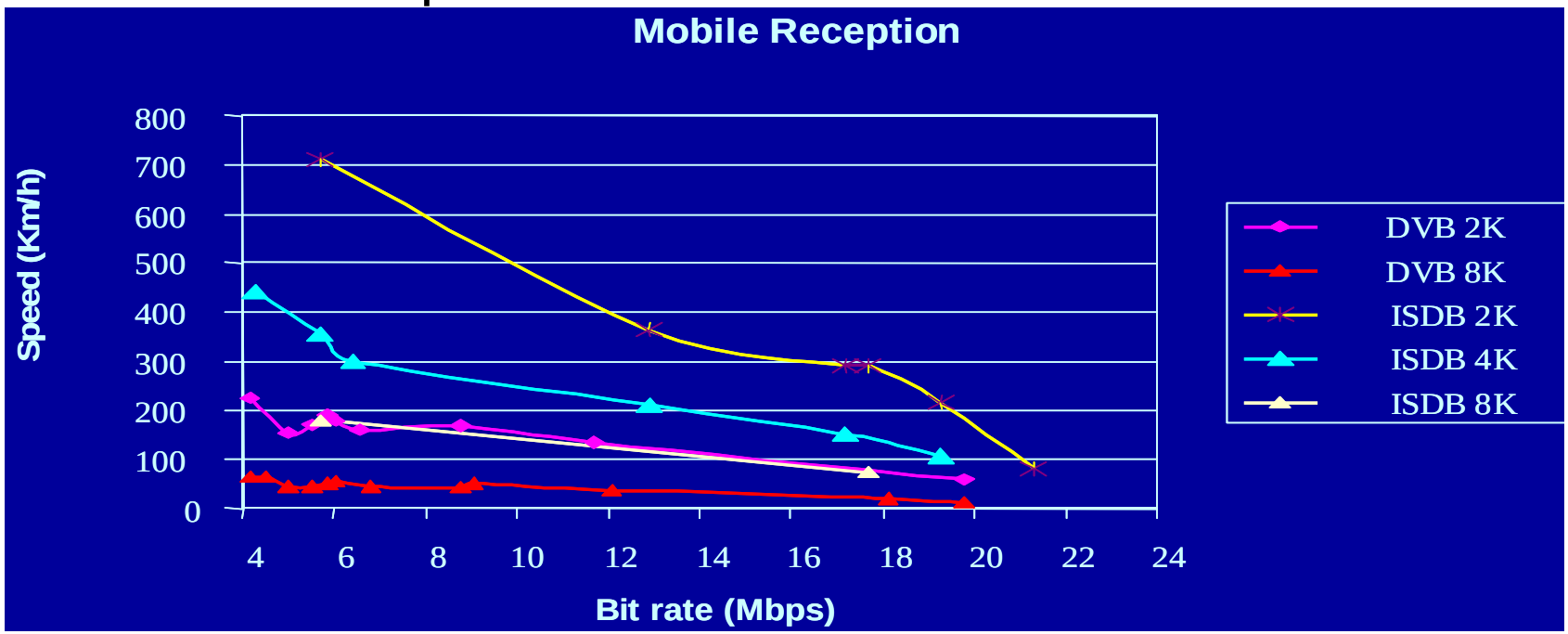
Laboratory Tests - Results

- 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.

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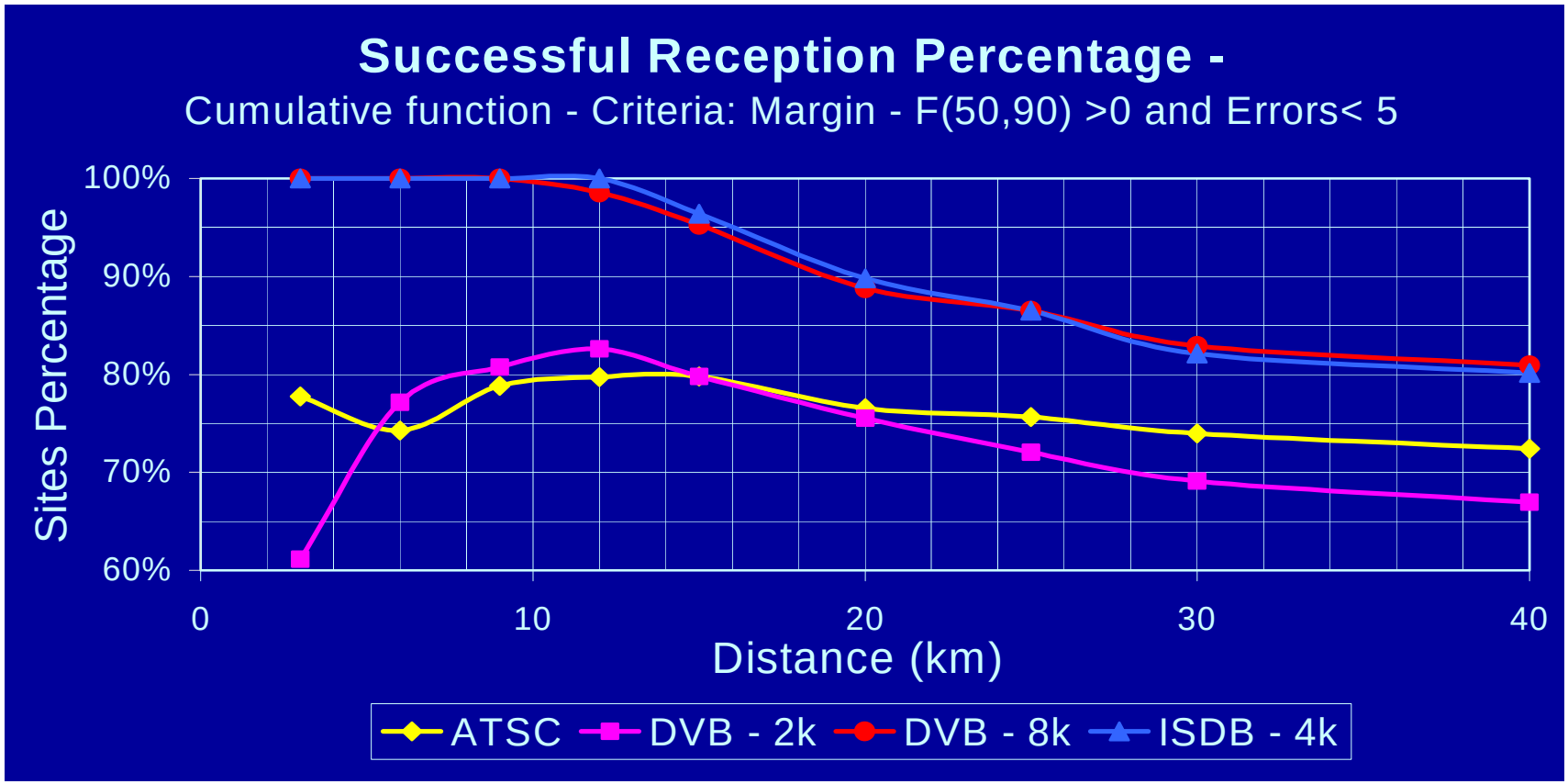
Field Test – Results Coverage



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

UK used DVB-2K at first
(Added by NHK)

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DTTV System Selection Guideline - 1

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

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DTTV System Selection Guideline - 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

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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.

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What's merit of ISDB-T for DTTV system ?

- Service flexibility and Inter-operability
- Merit of transmission characteristics

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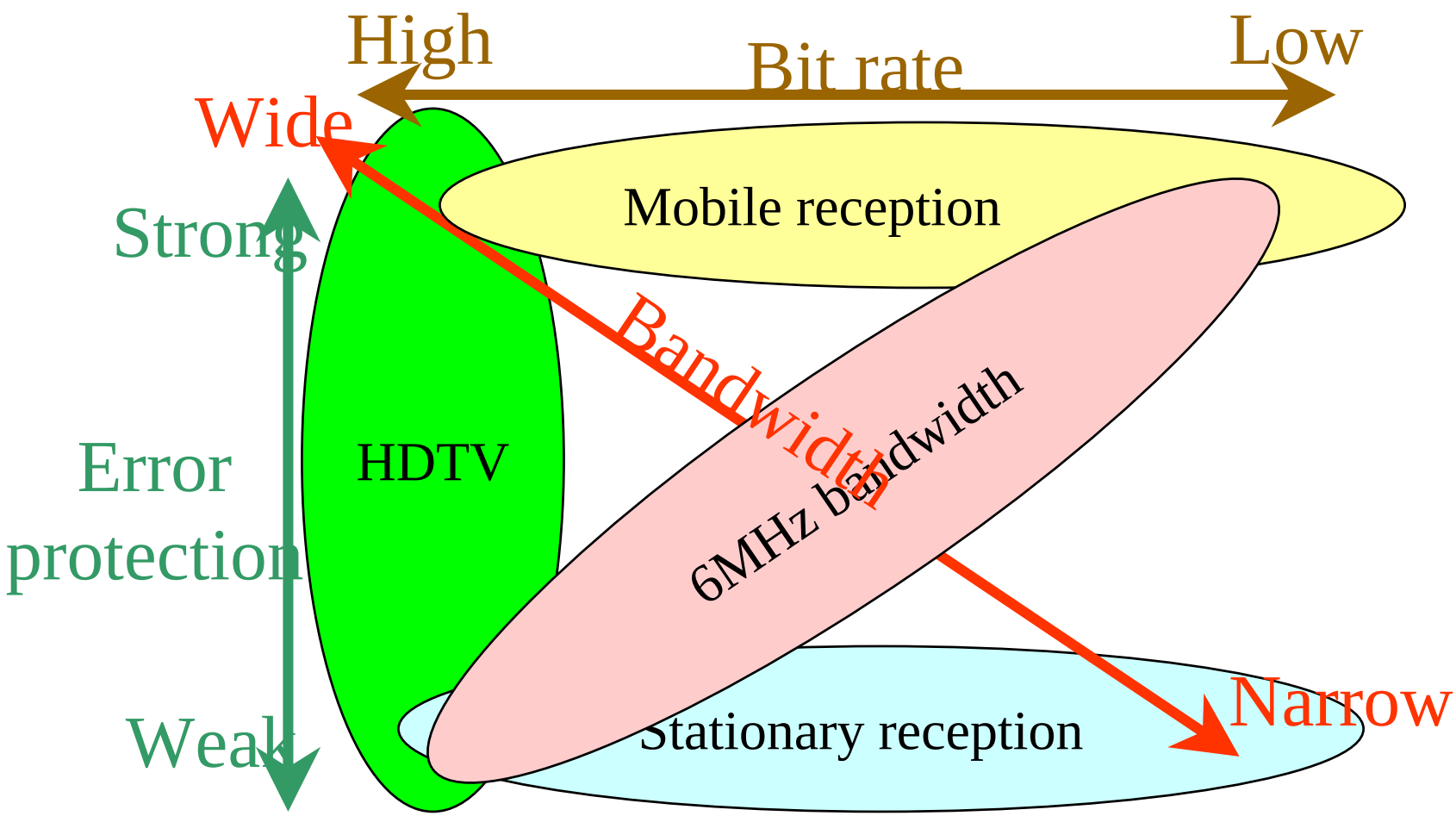
Diagram of Requirements



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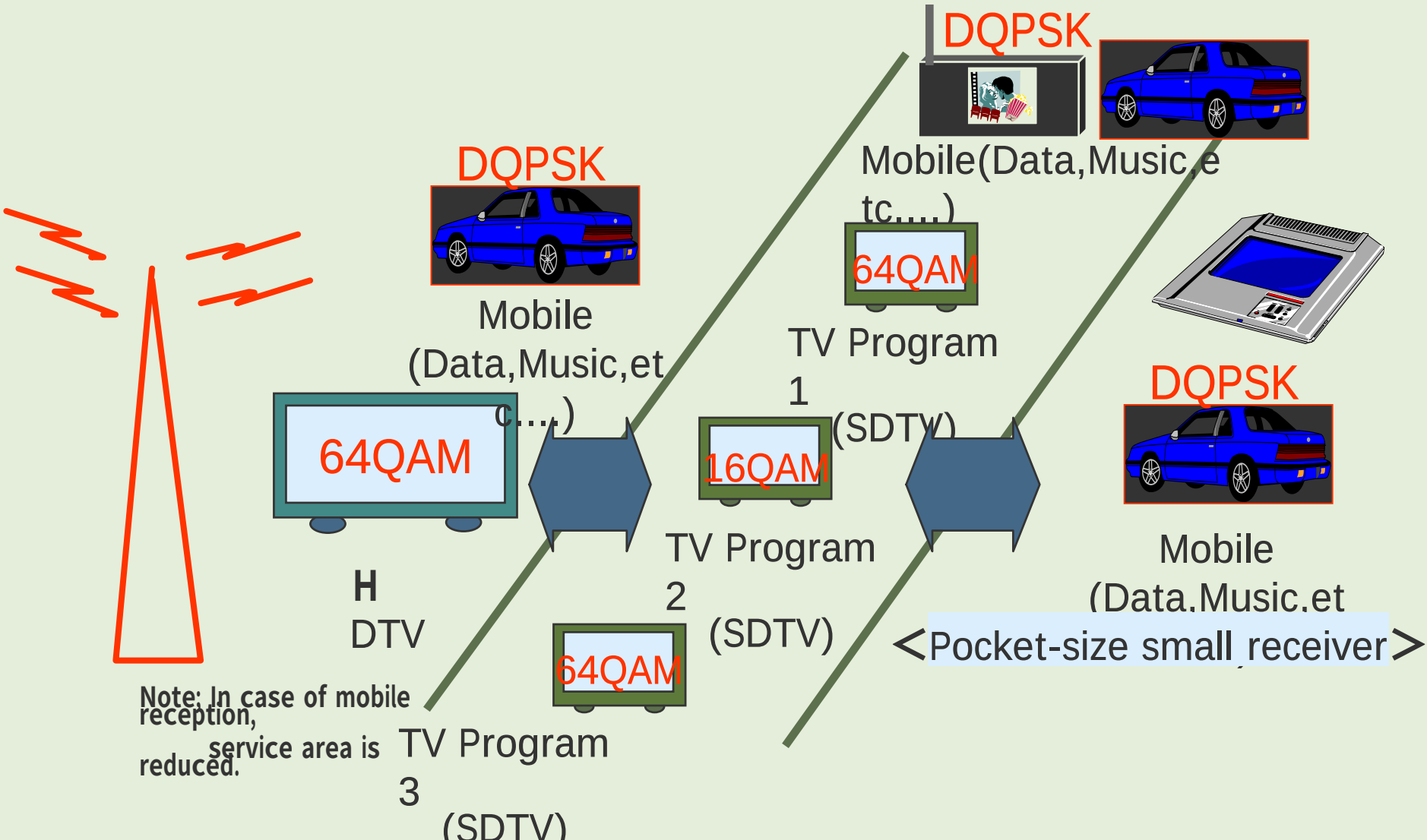
ISDB-T Mobile Reception and Flexibility of services



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How ISDB-T developed?

-Pilot test in Japan

-Development of mobile receiving technology

-Proto type of Digital Audio/one segment receiver

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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.

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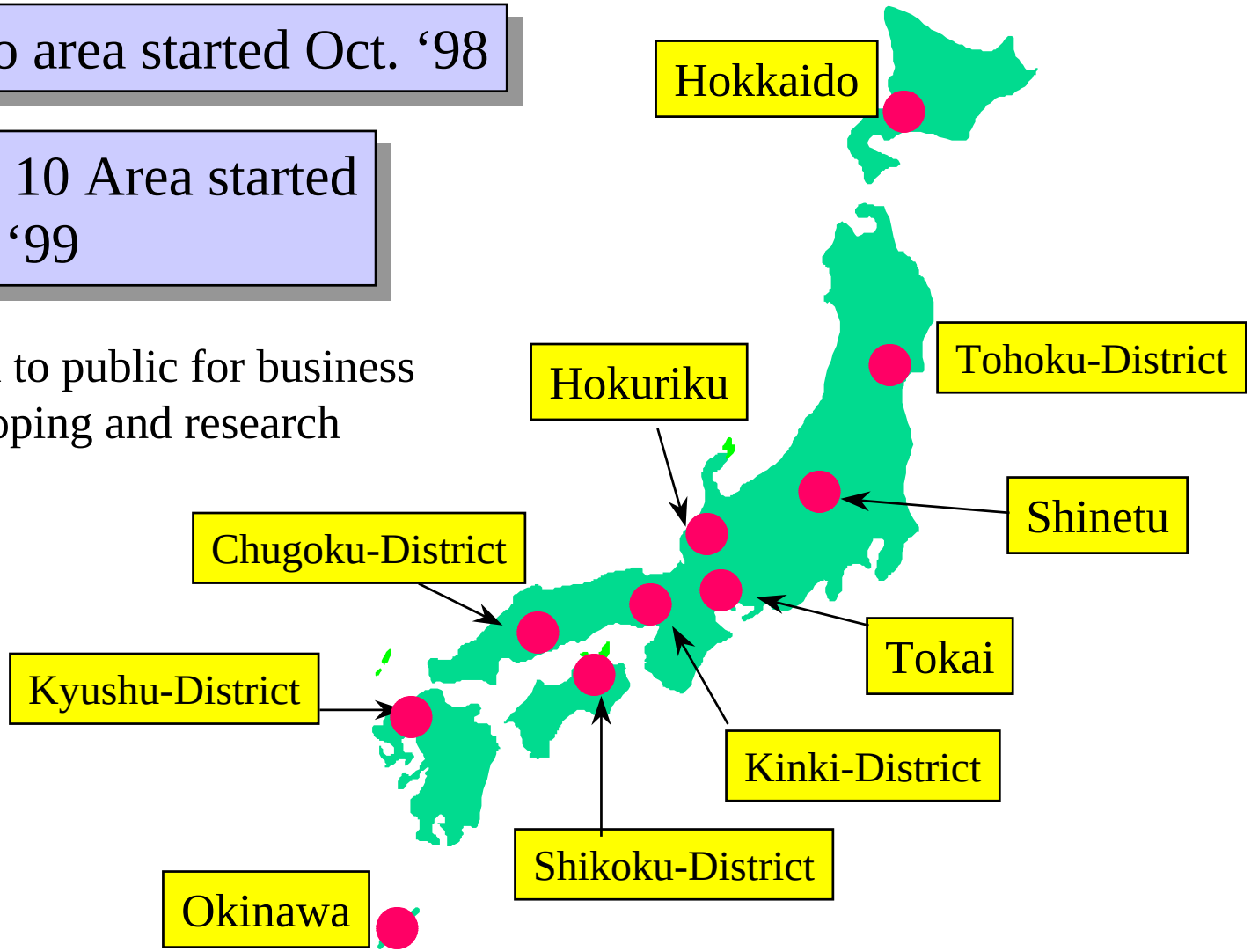
Experimental Broadcasting in Japan

for new business promoting

Tokyo area started Oct. '98

Other 10 Area started April '99

-Open to public for business developing and research



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Experimental Broadcasting in Japan

for System finalization of ISDB-T

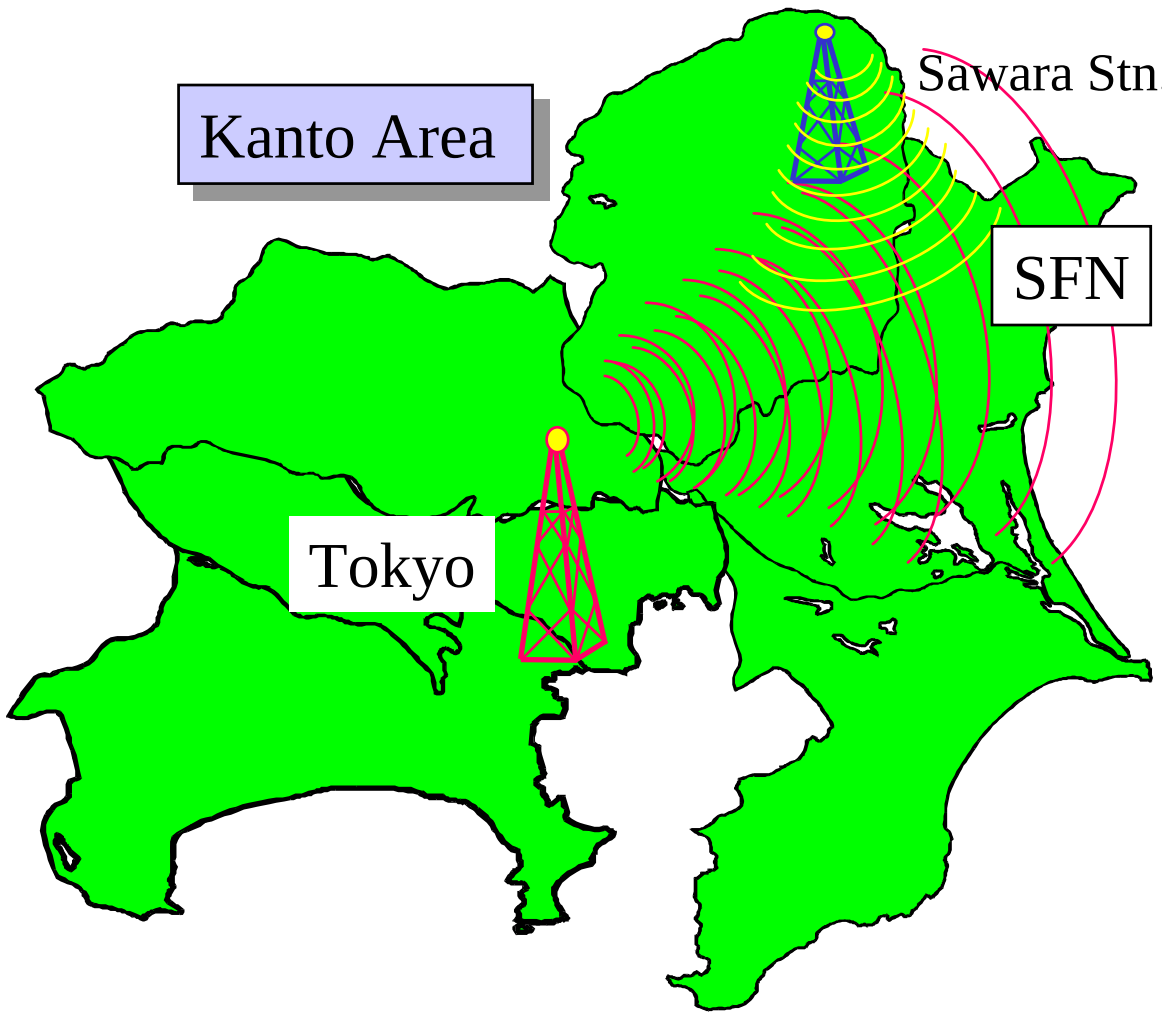
Transmitting started since Oct.'98

Tokyo Tower

Height 210m
CH UHF-15
Power 500W

Existing Analog TV

Ch-14 50kW
Ch-16 10kW



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Block Diagram of Tokyo Pilot Project

MPEG -2 ENC

V / A → SDTV 480i ENC
V / A → SDTV 480i ENC
V / A → SDTV480i ENC
A → Audio ENC
V / A → SDTV480p ENC
V / A → HDTV1080i ENC

EPG&Data Sending Equip.
Caption Sending Equip.

TRANSMISSON EQUIP

MUX

F E C ENC → OFDM MOD

TMCC

TMCC:Transmission and Multiplexing Configuration Control

COAX. EQUIP

DUMMY
COAX. SW
OPF

TV TX

RF AMP
LIN CORR UP -CON
LOCAL OSC

RELAY TRANSMISSON EQUIP

DELAY → IF → OPT TX → OPT RX → LIN CORR UP -CON
DIST
OPT RX → OPT TX → LOCAL OSC

RECEIVER

BPF → DOWN CON → OFDM DEMO → FEC DEC → TS DIST → HDTV MON
TS DIST → SDTV DEC → V / A
TS DIST → HDTV DEC → A / V

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Mobile Reception

Digital

Analog

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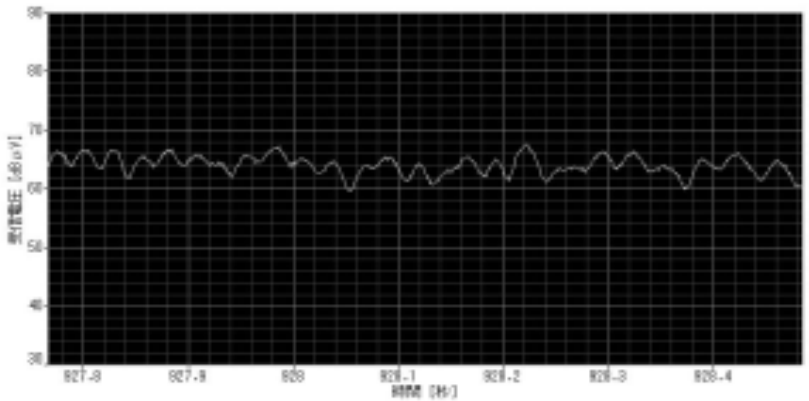
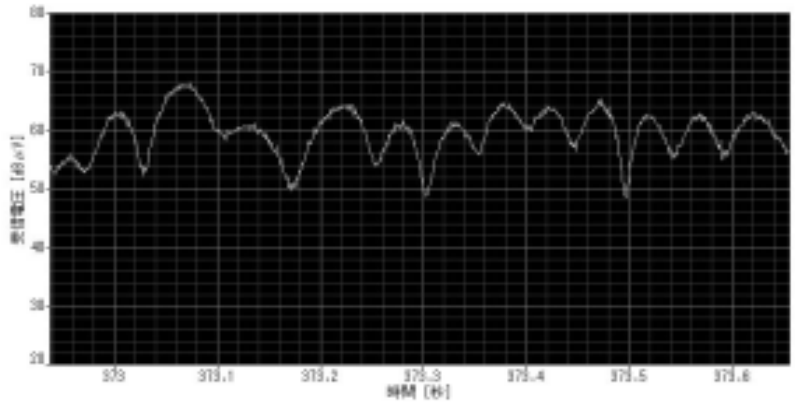
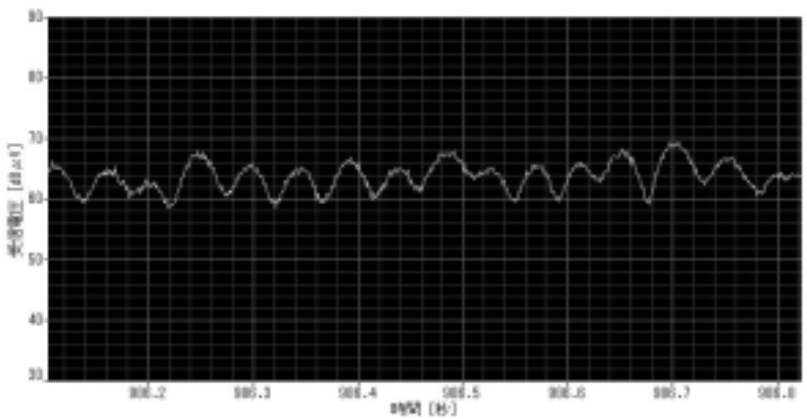
The fluctuation situation on electric field strength by mobile reception



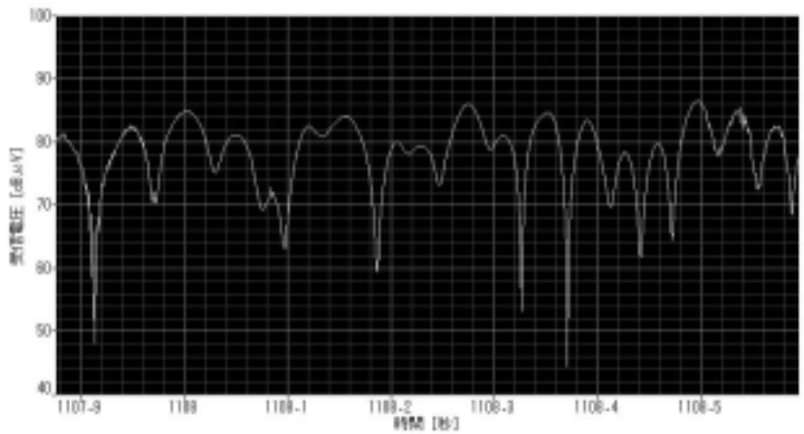
Example of fluctuation（bandwidth:6MHz）



Example of fluctuation （bandwidth:300kHz）



Example of fluctuation （bandwidth:1.5MHz）



Example of fluctuation (NTSC Audio carrier)

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720P Transmission Experiment Situation of Demonstration

720P and 480P simultaneous broadcasting

480p and 720p DEC

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SDTV 3channels transmission

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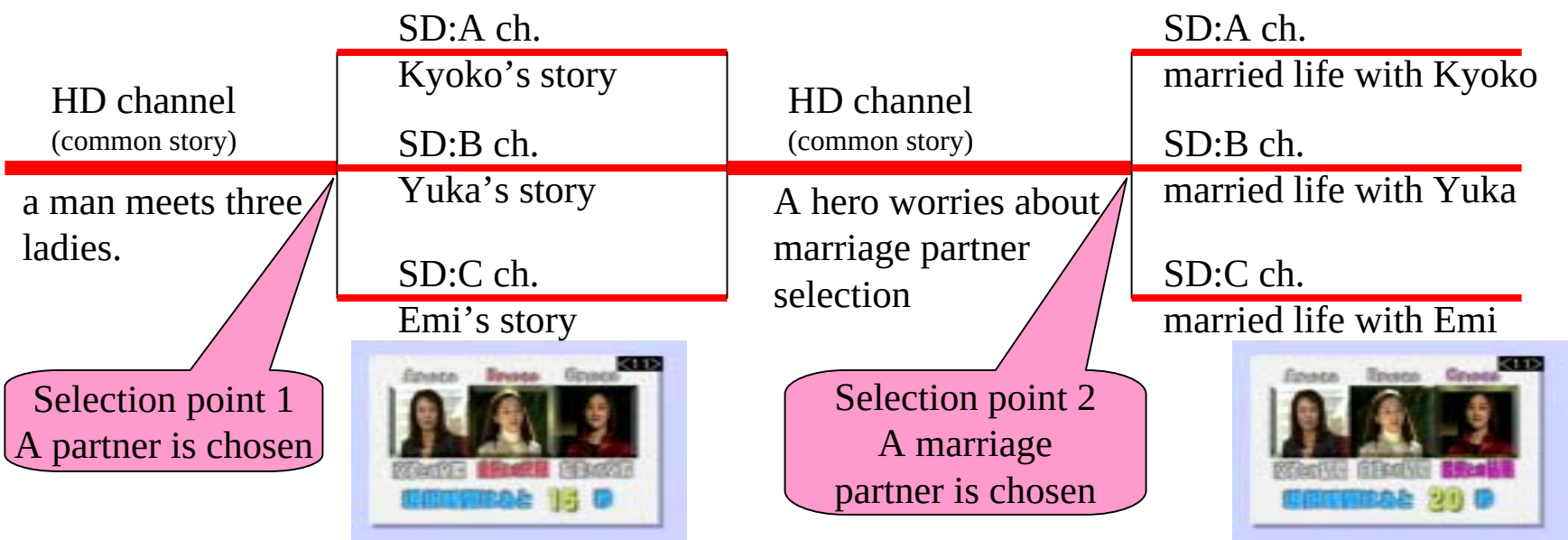
The drama which a story can choose by liking

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



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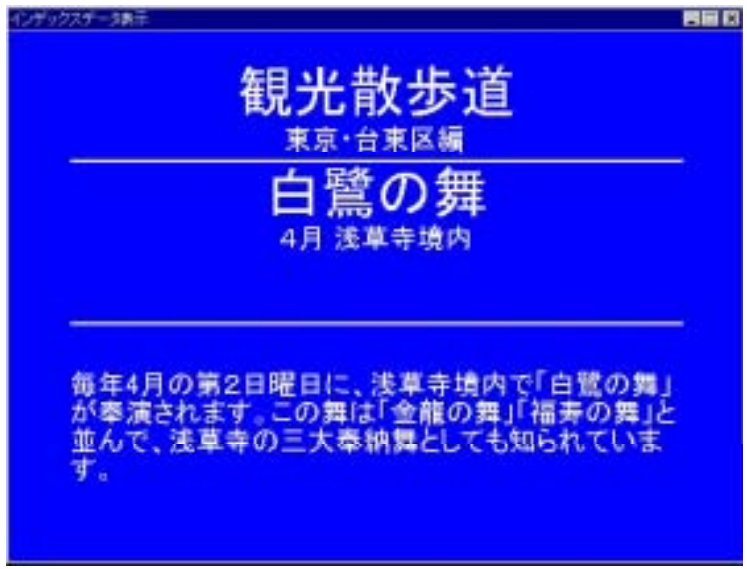
The receiving screen of hirerarchial transmission

Upper class receiving

Middle class receiving

Lower class receiving



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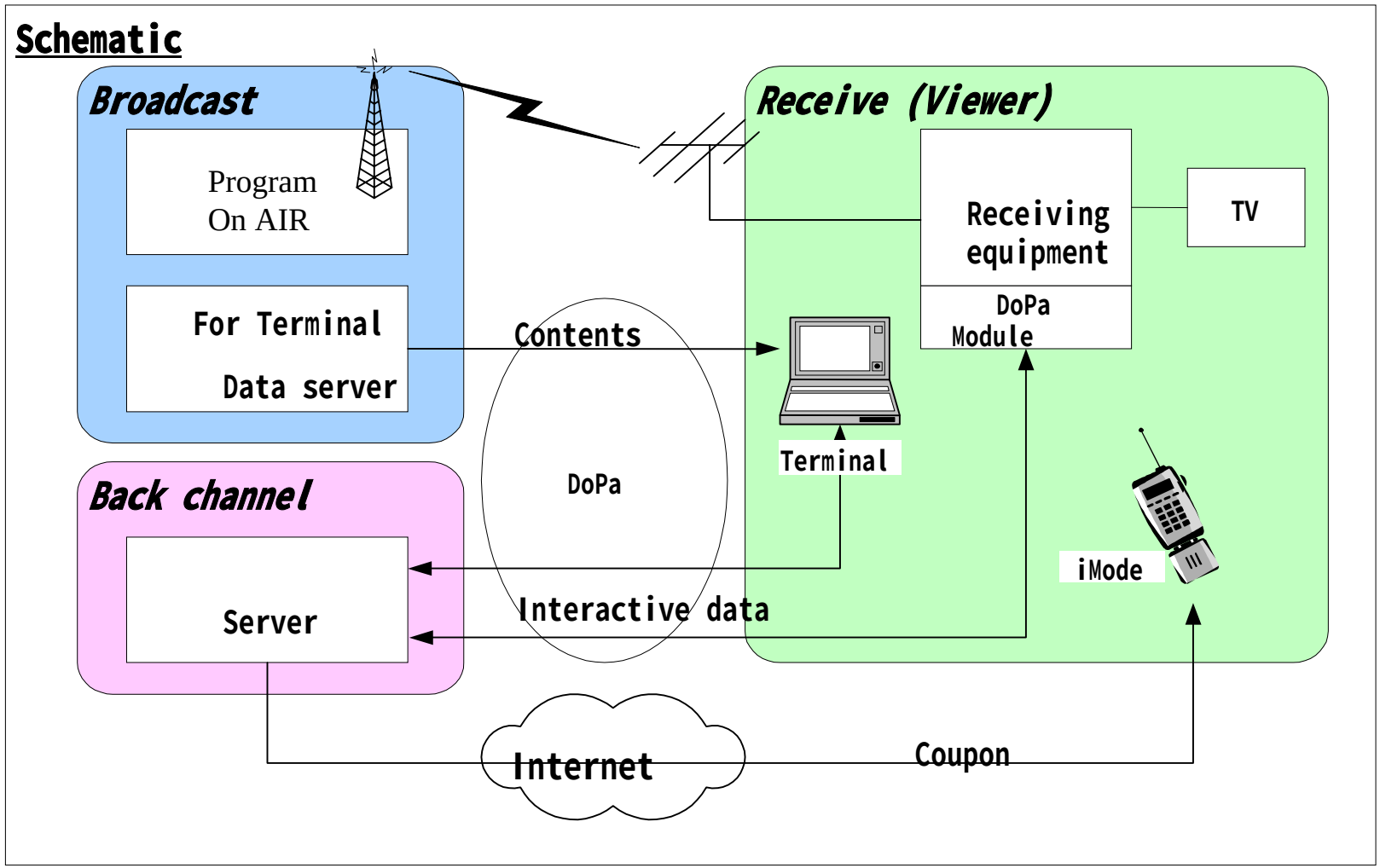
Schematic of interactive service for mobile reception



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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 %**

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Mobile Reception of HDTV

NHK

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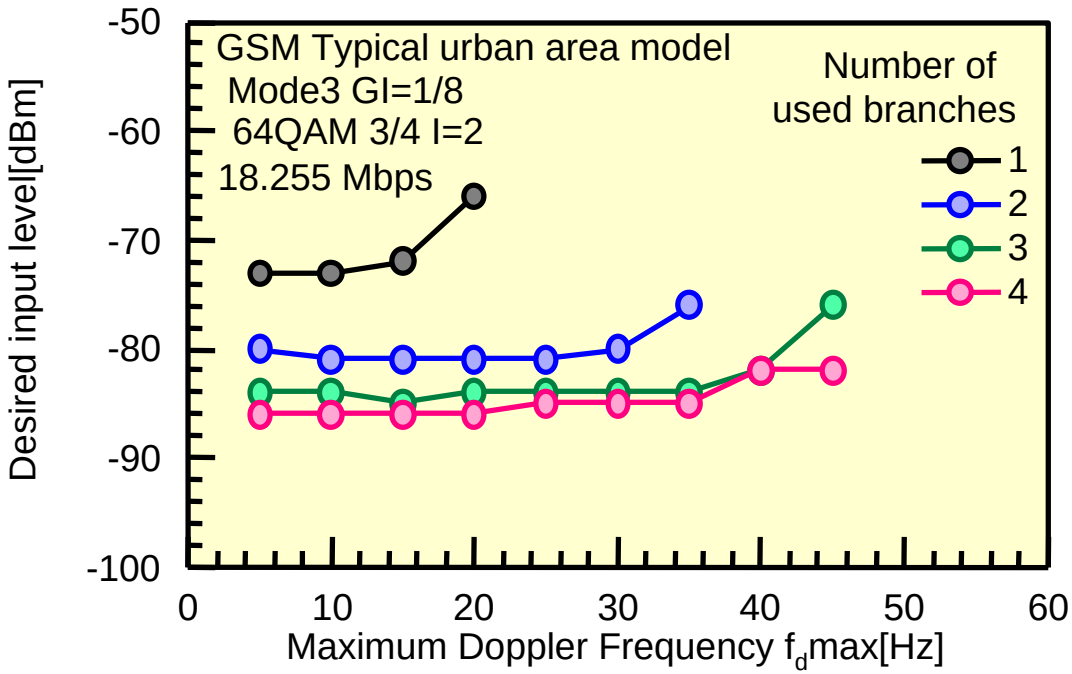
Result of Indoor Test on ISDB-T Diversity Reception System



Number of Branch	$f_d$max	Velocity@19ch ($v = f_d\text{max} \times l$)	Velocity@62ch ($v = f_d\text{max} \times l$)	Desired input level (@ $f_d$max =20Hz)
1	20Hz	42 km/h	28 km/h	-66 dBm
2	35Hz	74 km/h	49 km/h	-81 dBm
3	45Hz	95 km/h	63 km/h	-84 dBm
4	45Hz	95 km/h	63 km/h	-86 dBm

35km/h improved

20dB improved

NHK

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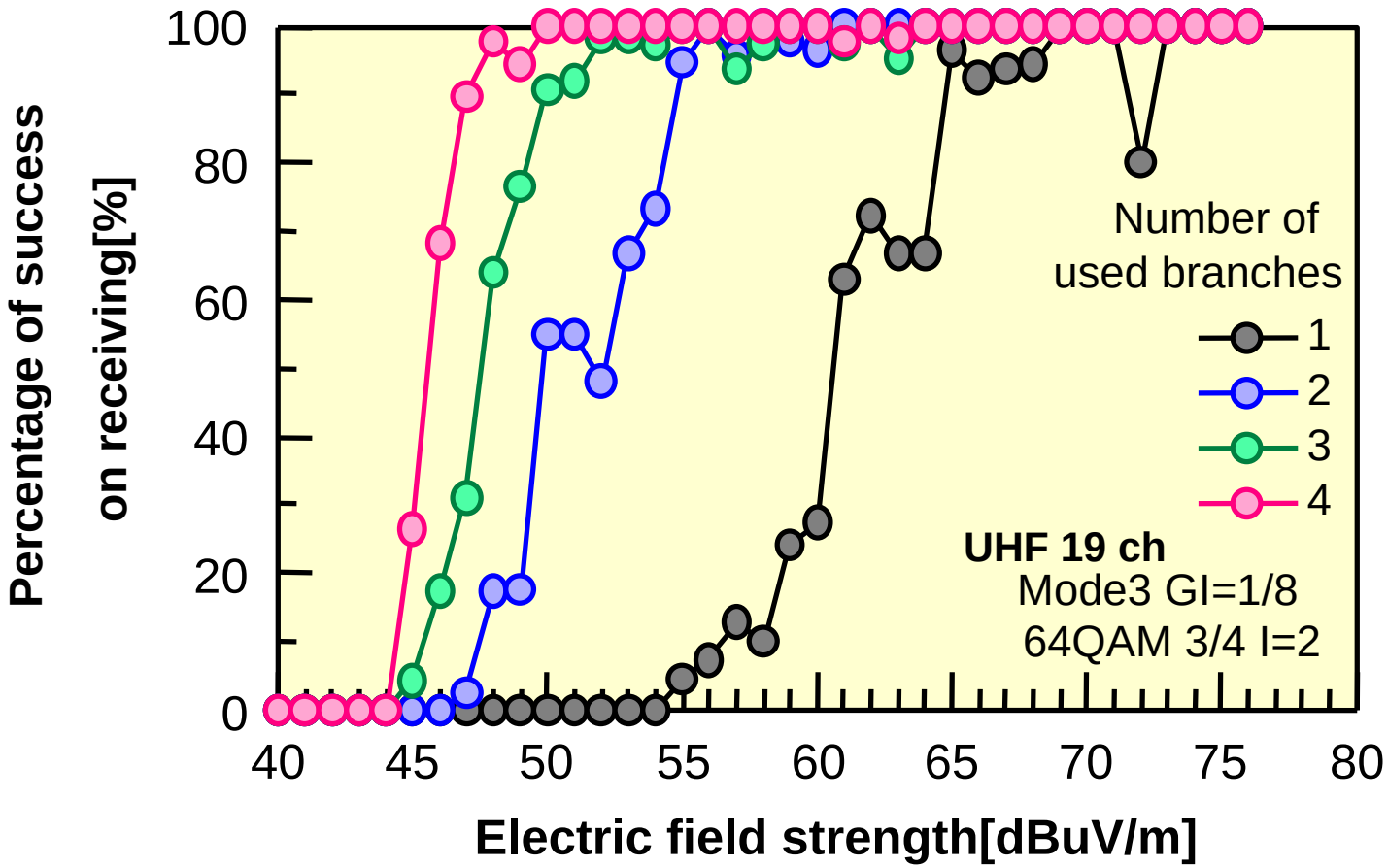
Result of Field Experiment



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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.

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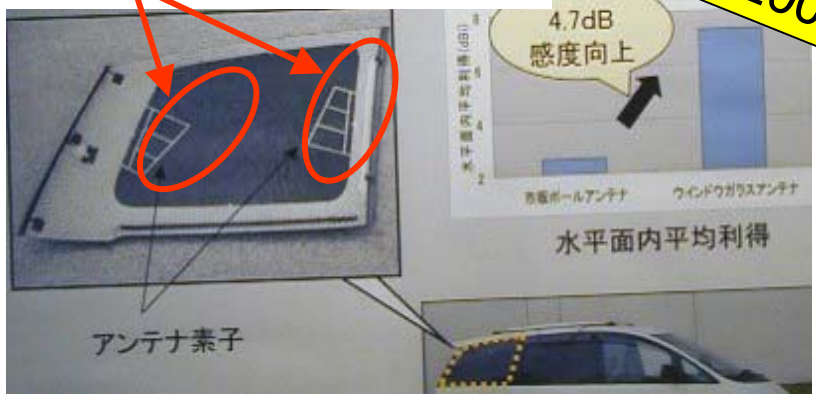
Toyota Central Lab demonstrated HDTV Mobile Reception using Adaptive Array Antenna

Jan 29,2003

Pole type antenna (conventional)

Adaptive Array Antenna



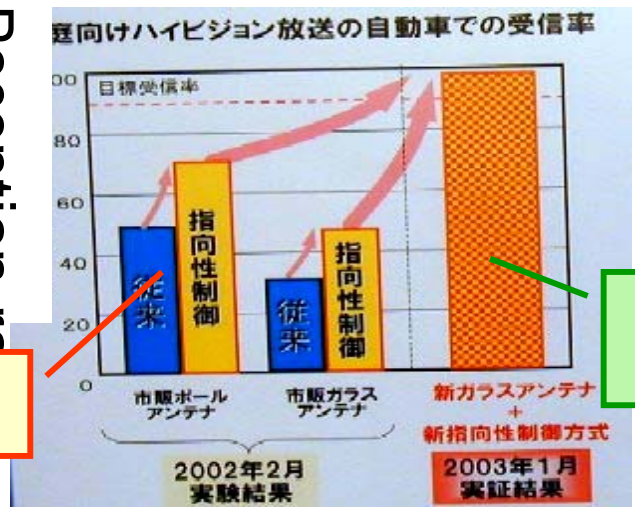
Adaptive Array Antenna attached on wind shield

UHF 15ch (whole segment reception)

Mode 3, 64QAM, 3/4

Guard interval: 1/8(128μs)

Threshold C/N=20.1dB



Reference: http://ne.nikkeibp.co.jp/DTV/2003/01/1000016922.html

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Prototype digital radio receiver (ISDB-Tsb)

Presented by DRP

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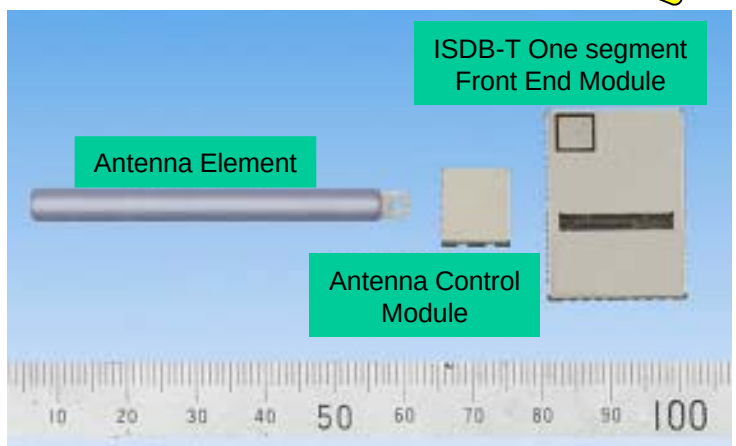
ISDB-T one segment Front-end module and Antenna

July 17 2003

- 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



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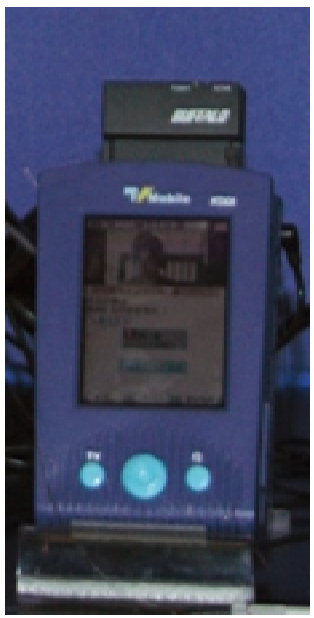
One Segment Service of ISBD-T for Cellular Phone



KDDI & NHK

Sanyo

NEC

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ISDB-T now in Japan (Commercial type receiver)

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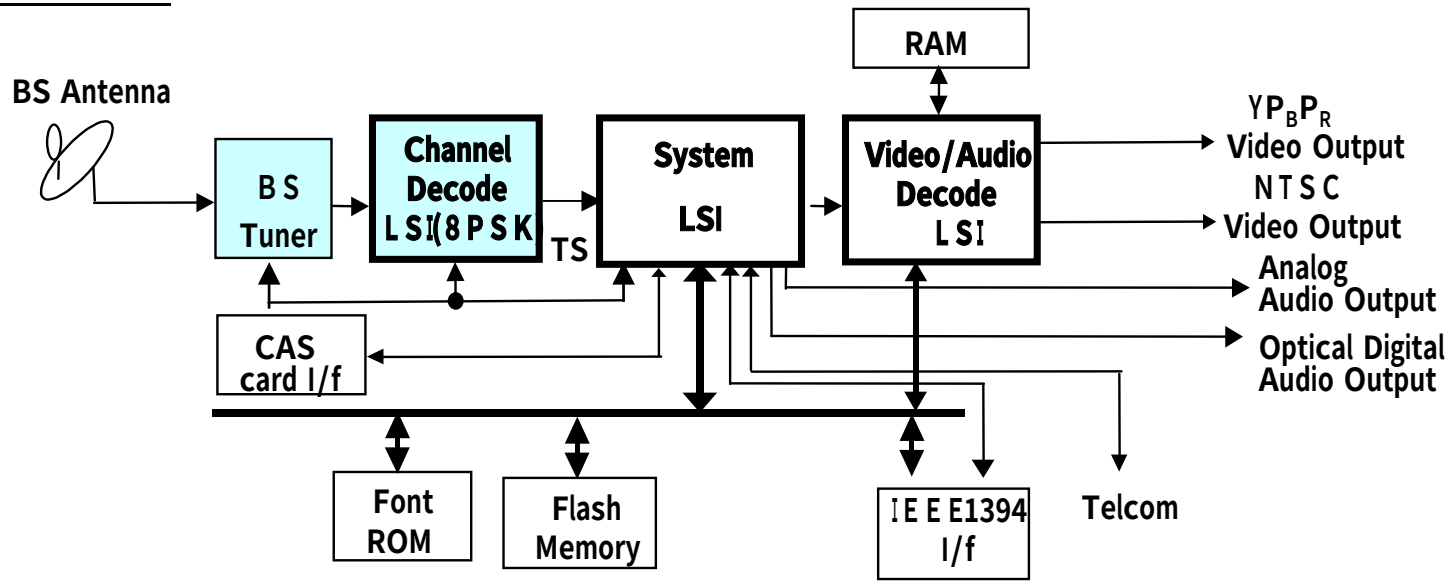
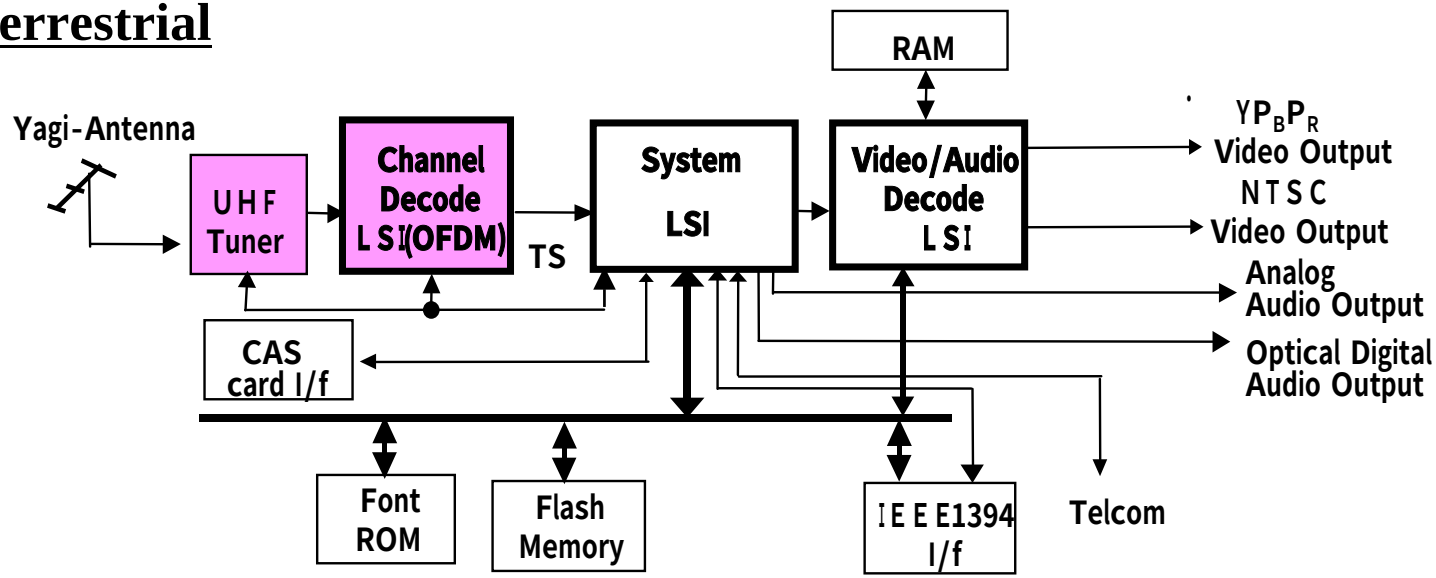
Block Diagram of ISDB-S and ISDB-T

ISDB - Satellite



ISDB - Terrestrial



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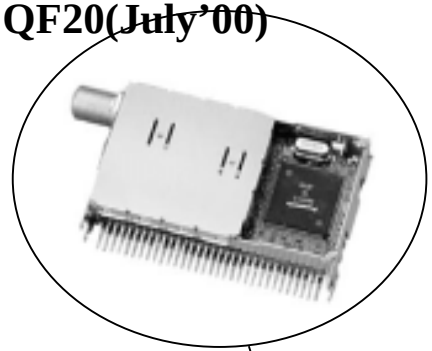
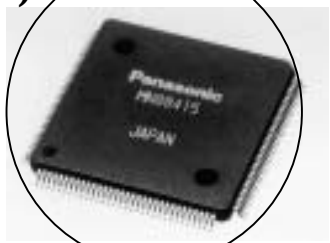
Key Technology for DTV Systems

BS-Tuner QF20(July'00)

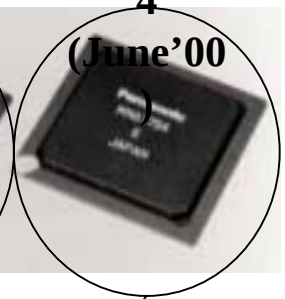


MN88415(June'99)



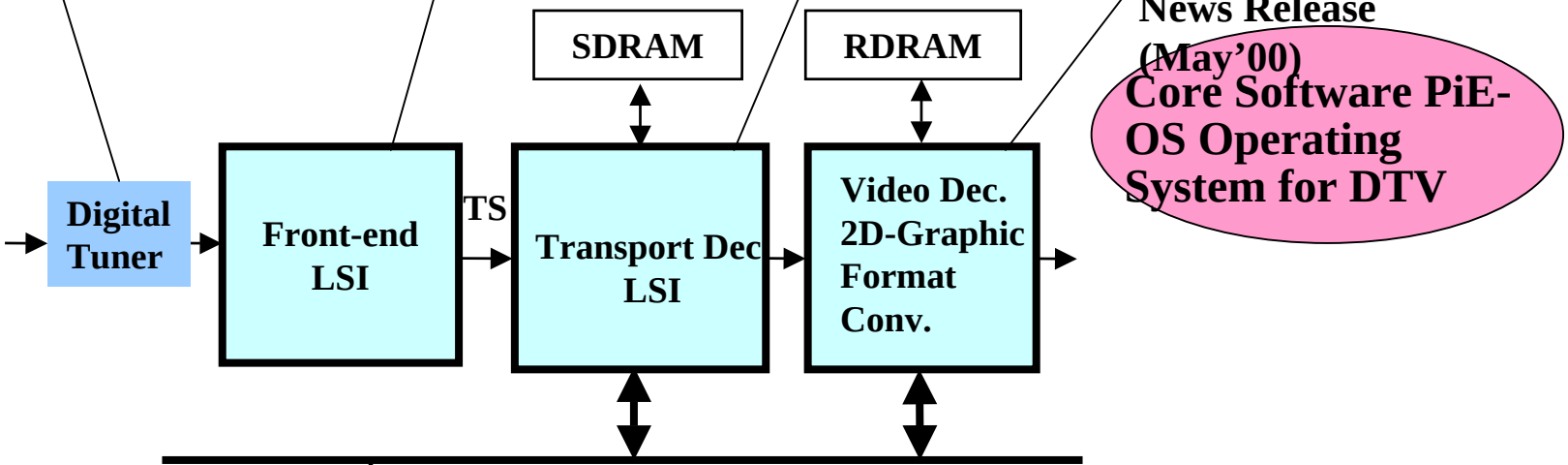
MN2WS0002BH (June'00)

MN67754 (June'00)

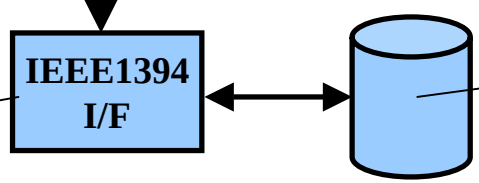


News Release (May'00)

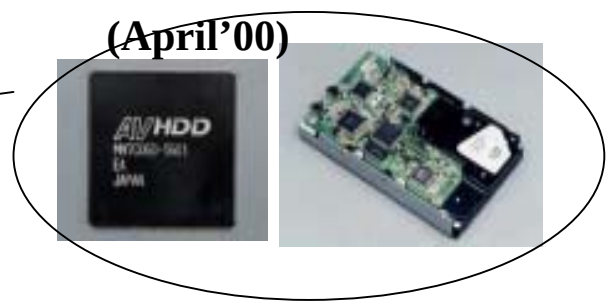
Core Software PiE-OS Operating System for DTV



MN864602(Jun'01)



News Release (April'00)



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Panasonic Announced the Sale of New PDP and LCD TV Sets

Aug 21

- ISDB-T tuner are installed in 37”, 42”, 50”PDP TV and 32”, 26”, 22” LCD TV.

37 42 50

LCD TV

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Sony Announced the Sale of New Digital TV Sets

Aug 28

- New models
  - PDP 61”, 50”, 42” 9models
  - LCD 42”, 37”, 32” 3models
  - CRT 28”, 32”, 28” 3models

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Thank you for your attention !

END