


# The ISDB-T System



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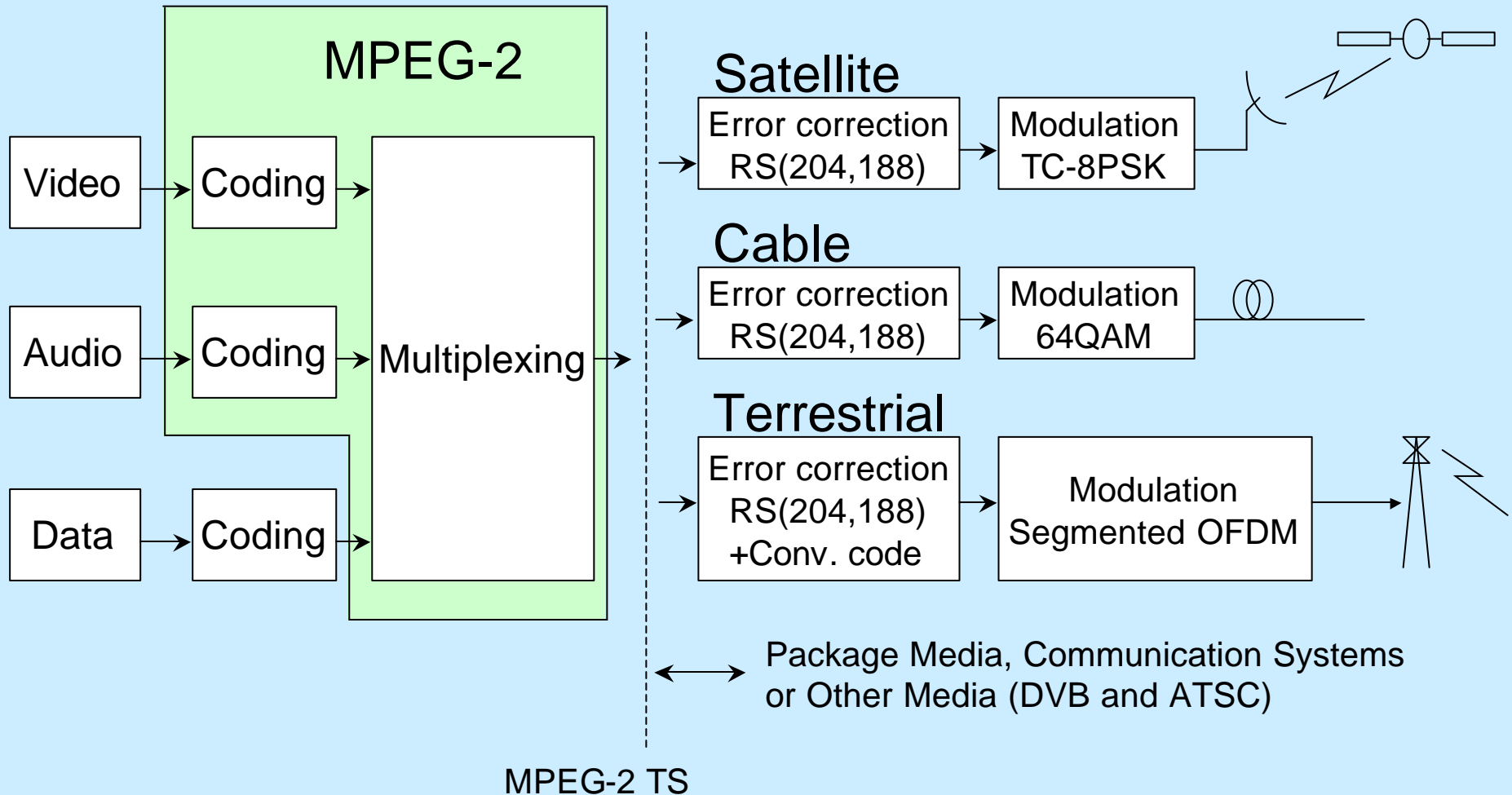


# Contents



- 1. Concept of ISDB**
- 2. Requirements for ISDB-T**
- 3. Transmission and Services**
- 4. Experimental Results**
- 5. Present Situation in Japan**
- 6. Conclusions**

# Concept of ISDB (Integrated Services Digital Broadcasting)



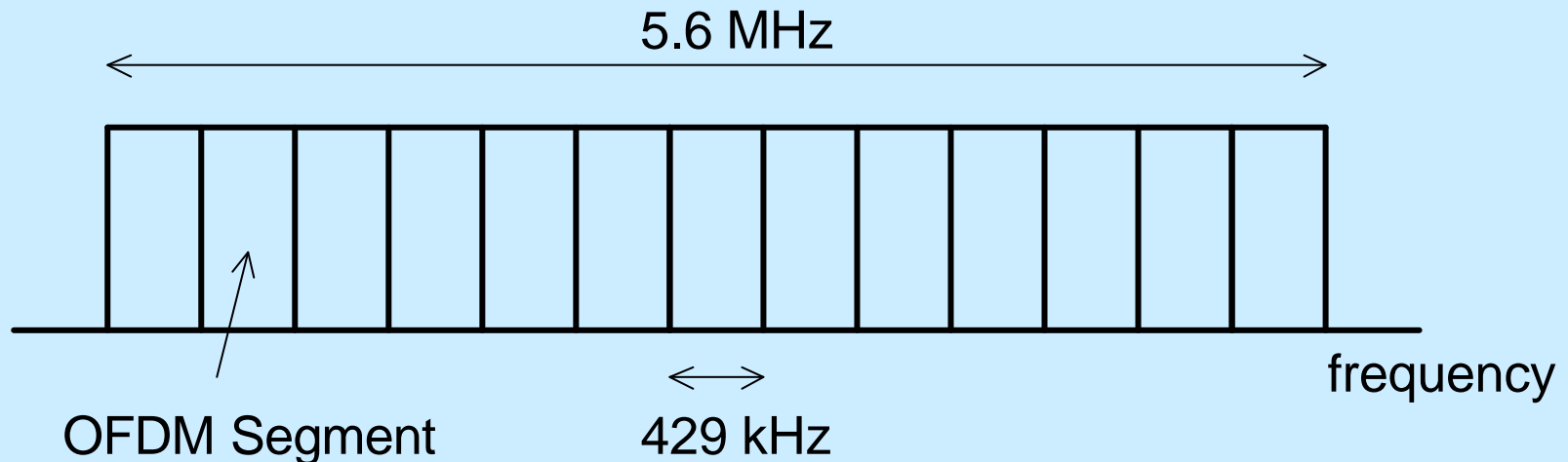
# Requirements for ISDB-T (ISDB-Terrestrial)



**ISDB-T** should

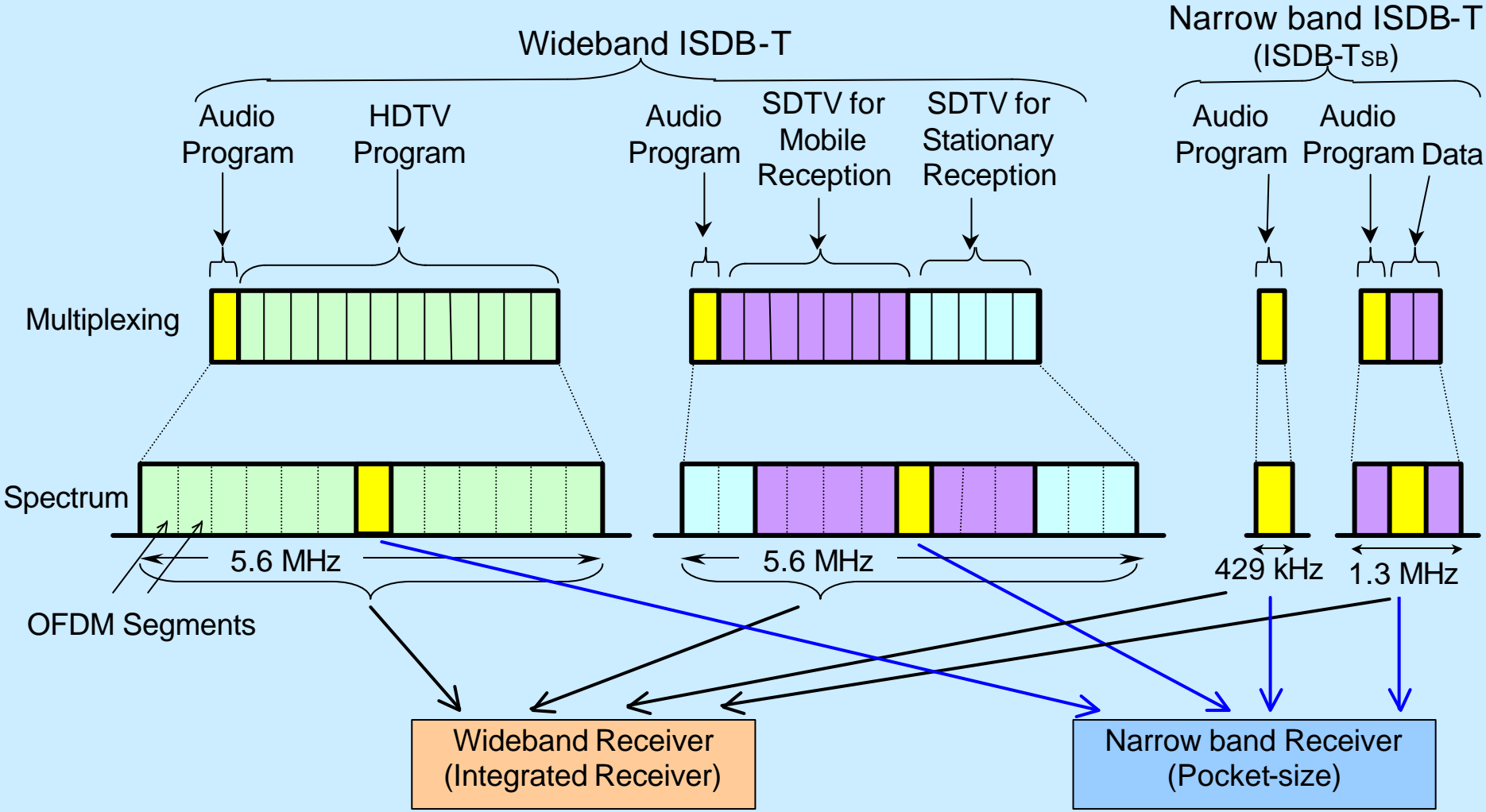
- have the capability to provide various services, including **HDTV, multi-channel SDTV, data services**, etc.
- have sufficient transmission quality for the **portable** and **mobile reception**.
- ensure **flexible use** of transmission capacity.
- be able to achieve effective use of frequency using **SFN** (Single Frequency Networks) technology.

# Modulation Scheme of ISDB-T (Band Segmented OFDM)



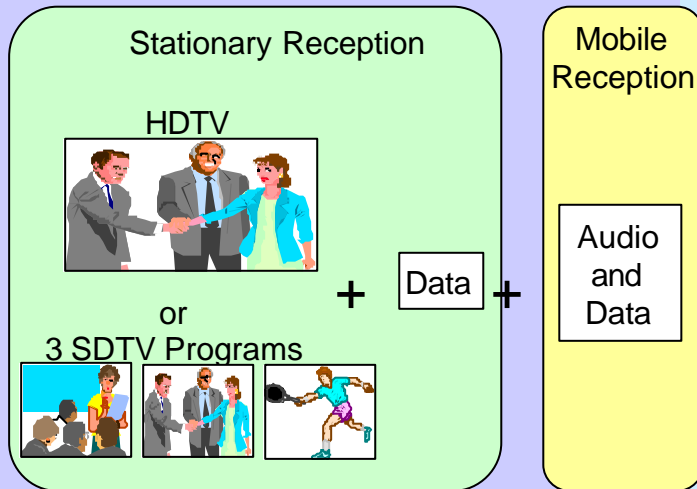
- Bandwidth of an OFDM segment is  $6/14$  MHz ( $\cong 429$  kHz).
- All segments have a common structure.
- Number of OFDM segments is 13 for wide-band ISDB-T and 1 or 3 for narrow-band ISDB-T.

# Multiplexing and Spectrum of ISDB-T

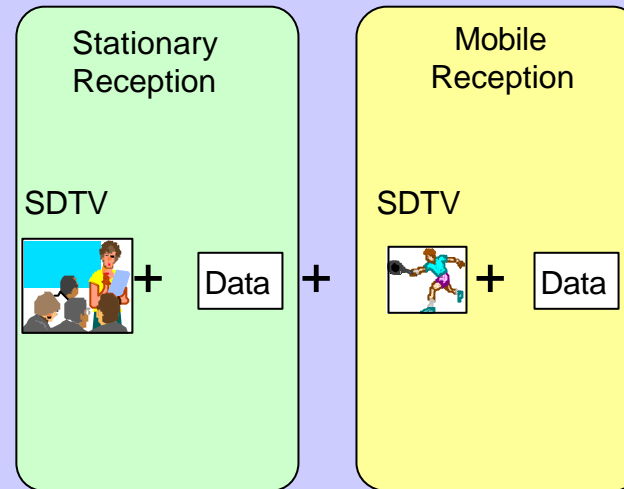


# Service Examples

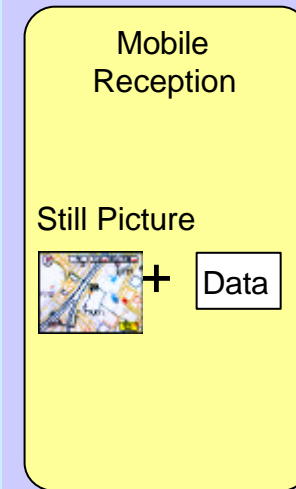
Example 1



Example 2



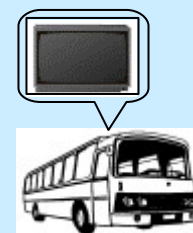
Example 3



Integrated Receiver  
(all services)



Car Receiver  
(Audio and Data)



Mobile Receiver  
(SDTV, Audio and Data)



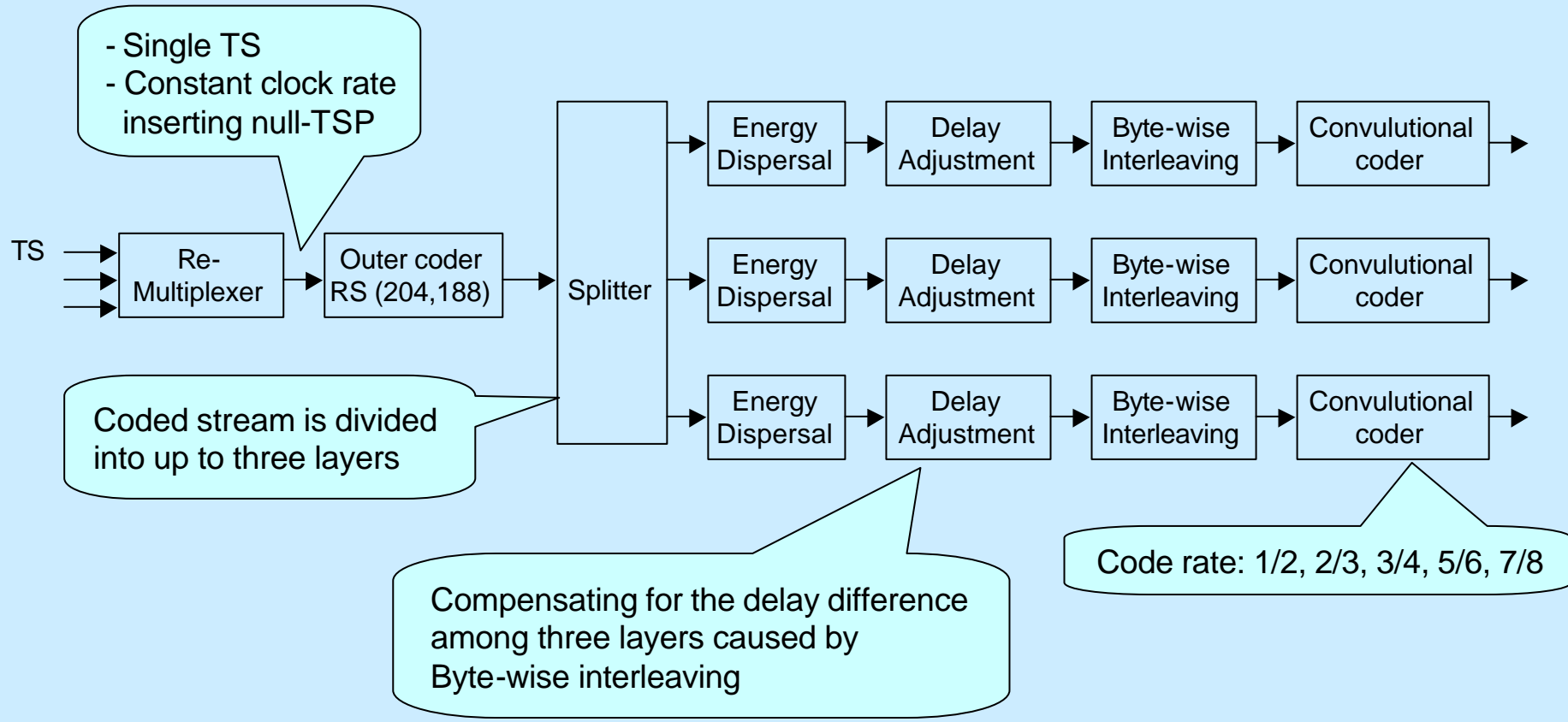
Pocket-size Receiver  
(Audio and Data)

# Parameters of ISDB-T (6MHz Bandwidth)

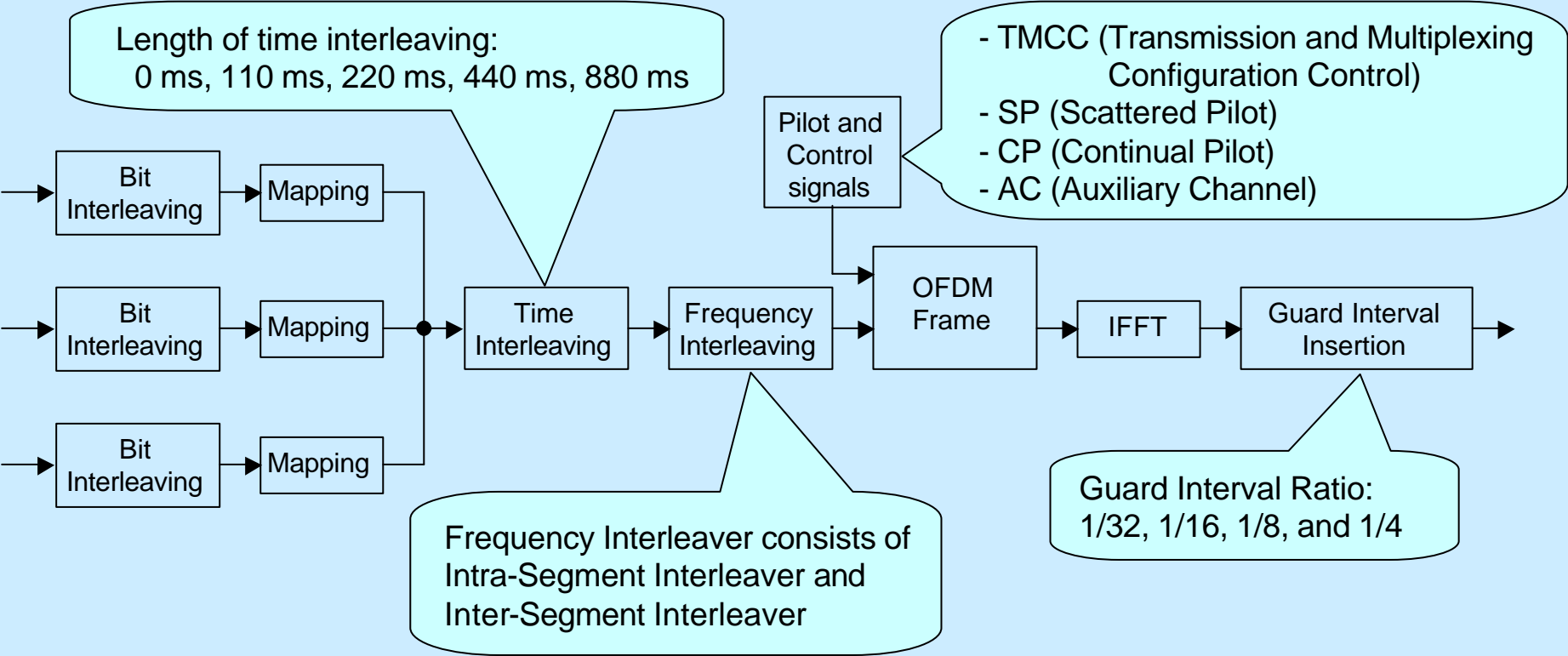
Parameters	Mode 1	Mode 2	Mode 3
Number of OFDM segments	13		
Useful bandwidth	5.575 MHz	5.573 MHz	5.572 MHz
Carrier spacing	3.968 kHz	1.984 kHz	0.992 kHz
Number of active carriers	1405	2809	4992
Modulation	QPSK , 16QAM , 64QAM , DQPSK		
Number of symbols per frame	204		
Active symbol duration	252 $\mu$ s	504 $\mu$ s	1.008 ms
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 interleaving	0 0.44 s		
Useful bit rate	3.651 Mbps	23.234 Mbps	



# Channel Coding



# Modulation



# Features of the Transmission Scheme of ISDB-T

- Different parameters can be set for each layer  
→ Wide variety of services
- Robust against fading in mobile environment  
→ Suitable for mobile reception
- Segment structure  
→ Partial reception is possible
- OFDM modulation → Effective use of frequency by SFN (Single Frequency Networks)

# Practical Experiments (Field Trials)



## Tokyo Pilot Experiments

### Phase 1 (November 1998 to March 1999)

HDTV, Multi-channel SDTV, Mobile reception, etc.

### Phase 2 (April 1999 to March 2000)

Data broadcasting, Multimedia services, EPG, etc.

### Phase 3 (April 2000 to March 2002)

Gap-fillers, Multimedia services, etc.

TOKYO TOWER



## Transmitting Station of Tokyo Pilot Experiments

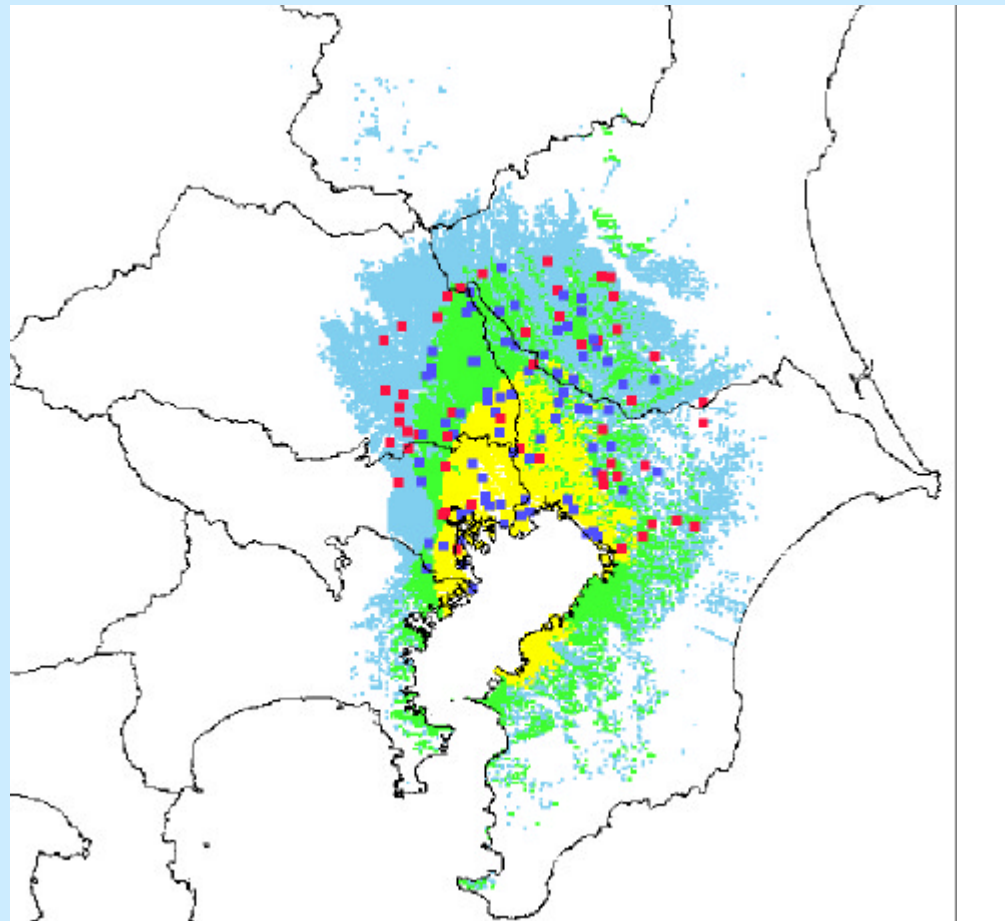
**Tx Antenna (261 m)**

**UHF 15 ch (485.15 MHz)**

**Tx power: 100 W**

**ERP: 395W**

# Field Trials (Fixed Reception)



BER (measured)

■ BER  $\leq 2e-4$

■ BER  $> 2e-4$

Field Strength (calculated)

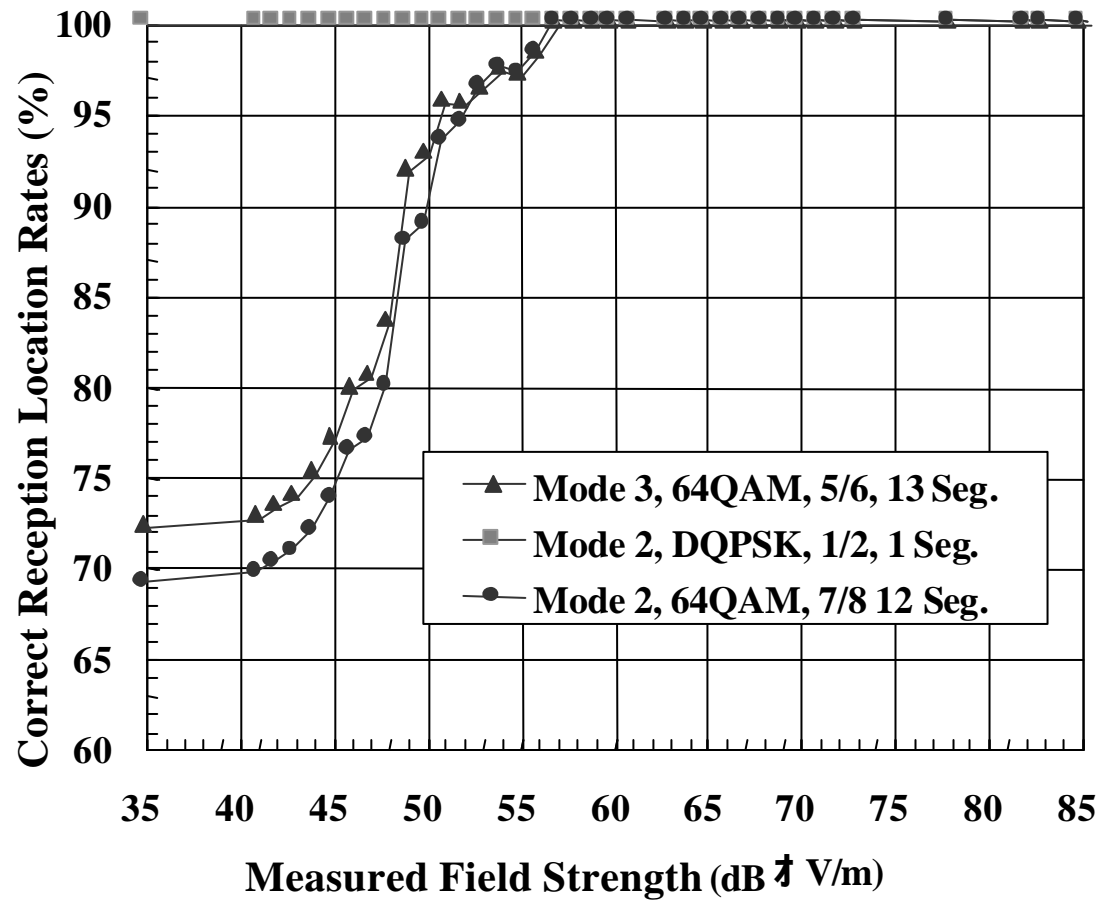
■  $> 70 \text{ dB}\mu\text{V/m}$

■  $> 60 \text{ dB}\mu\text{V/m}$

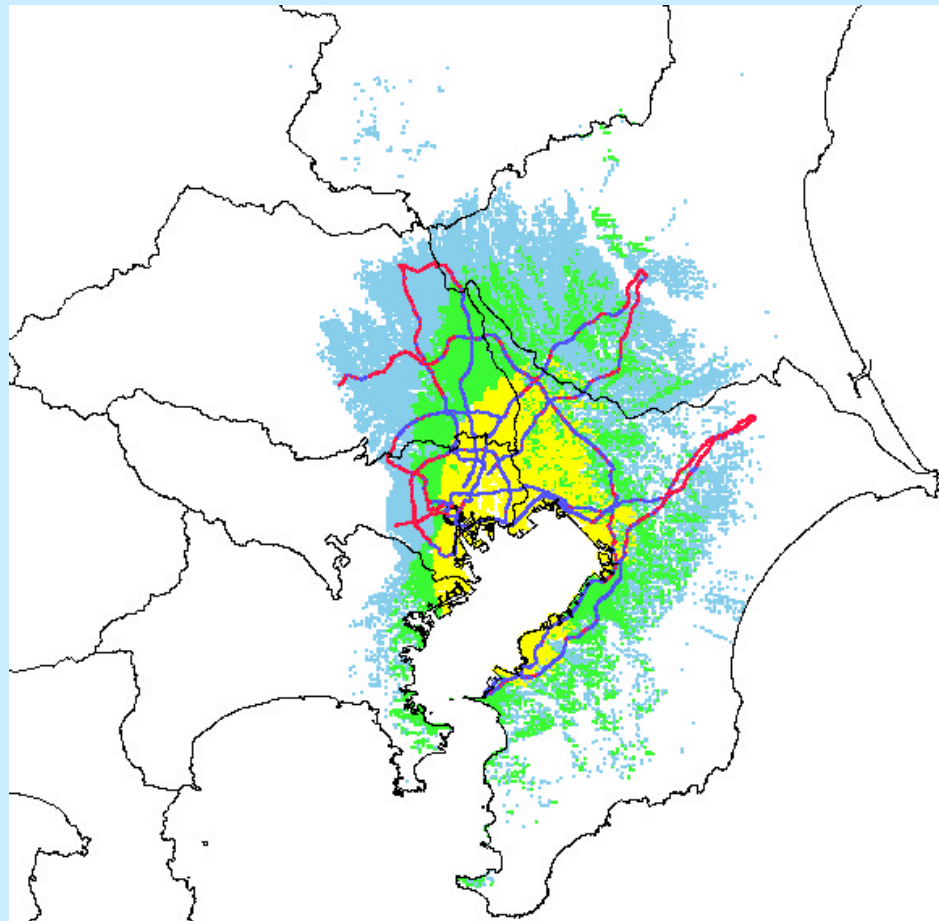
■  $> 50 \text{ dB}\mu\text{V/m}$

0 50 km

# Correct Reception Rate (Fixed Reception)



# Field Trials (Mobile Reception)



Total measured distance  
- about 3000 km

BER (measured)

■ BER ≤ 2e-4

■ BER > 2e-4

Field Strength (calculated)

■ >70dBμV/m

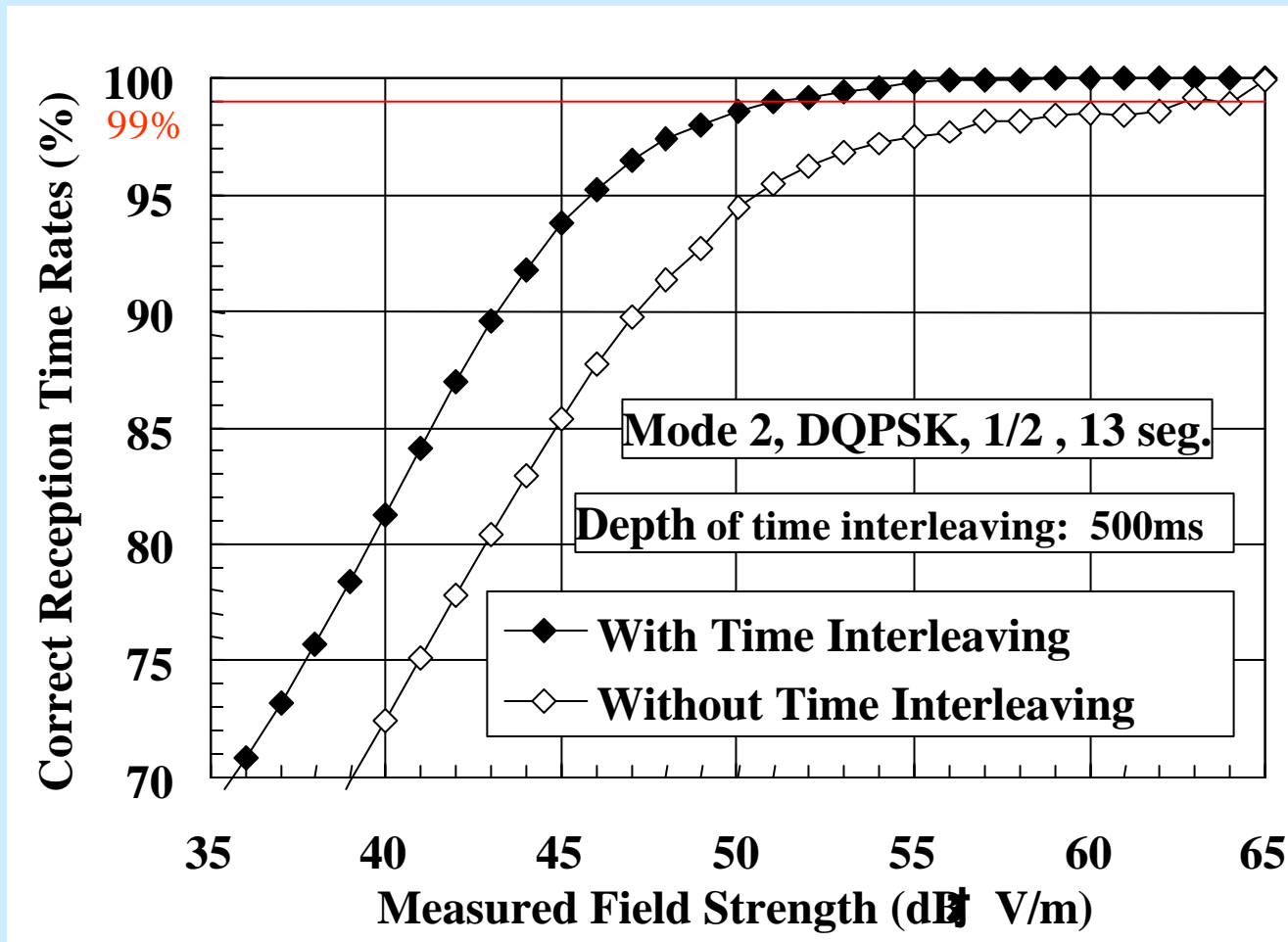
■ >60dBμV/m

■ >50dBμV/m

0 50 km



# Effect of Time Interleaving (Mobile Reception)



# Pilot Experiments in 11 Areas in Japan

Started in April 1999

Purposes:

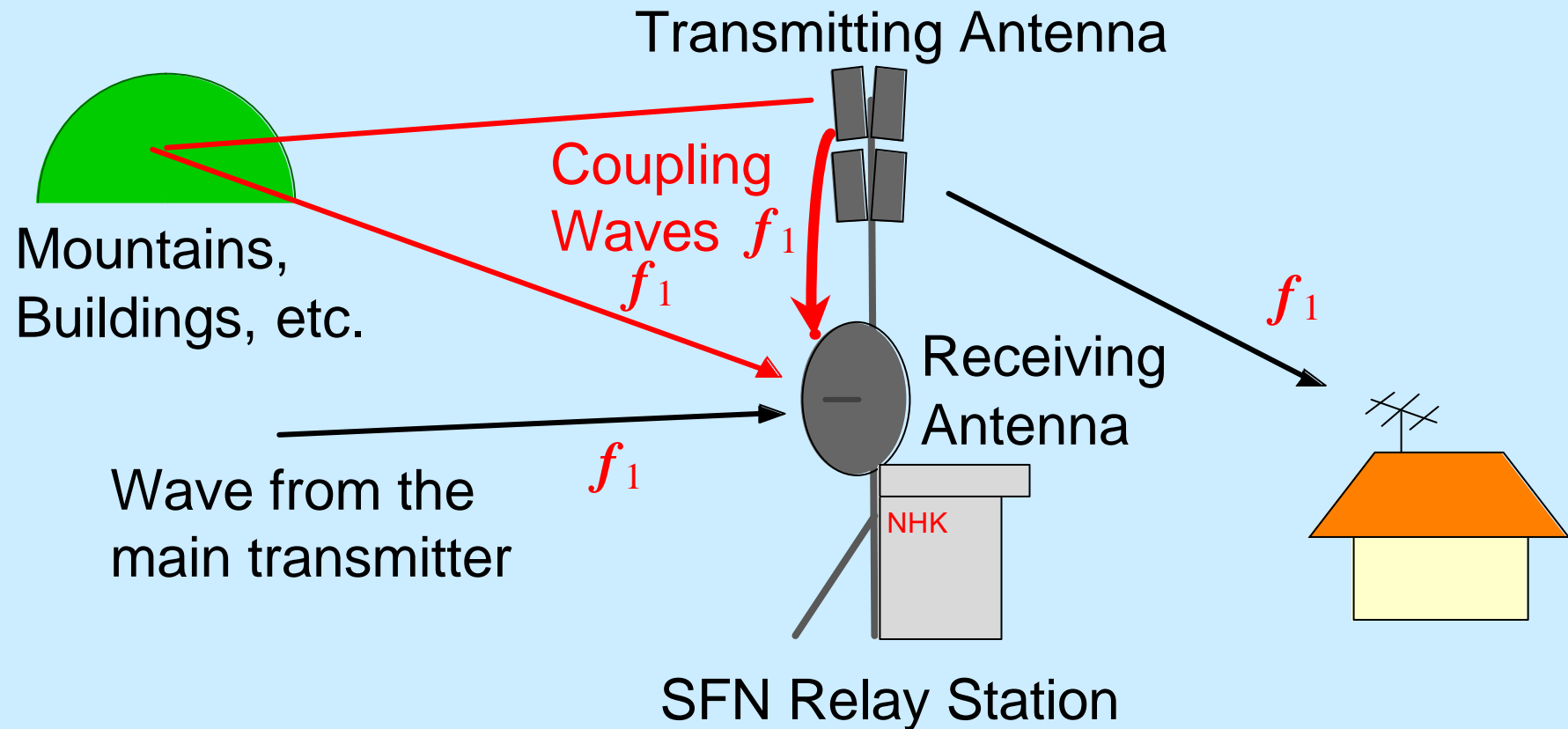
- ‡ Development of new services suitable for each region
- ‡ Confirmation of receiving area
- ‡ Training engineers, etc.



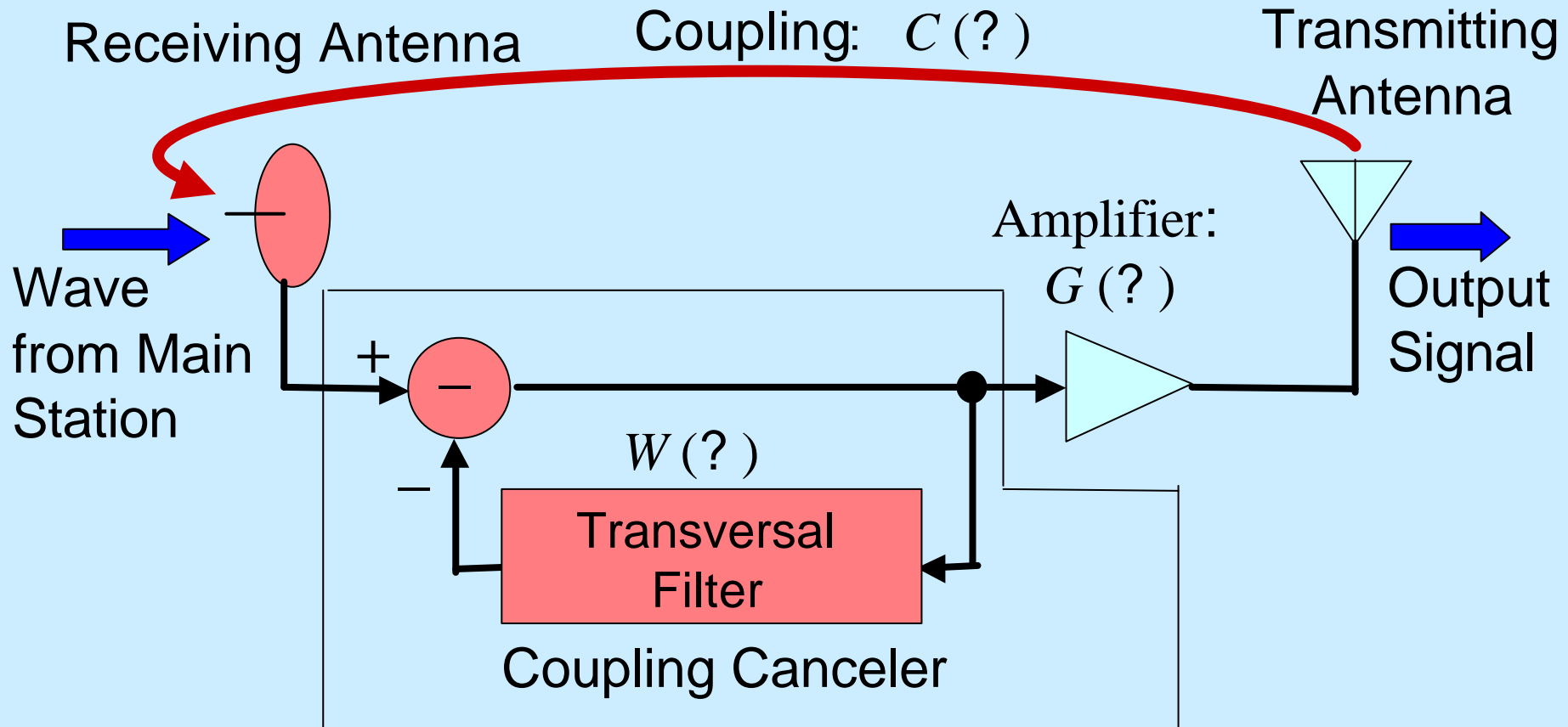
# Study on Single Frequency Networks (Development of coupling cancelers)

- Distribution methods of ISDB-T signals from main transmitters to relay transmitters
  - **Micro Wave**
    - Frequency for this purpose is necessary
  - **Optical Fiber**
    - Construction and running cost is high
  - **Relay Networks**
    - Low cost
    - **Interference by coupling waves is the problem**

# Coupling Waves at Relay Stations

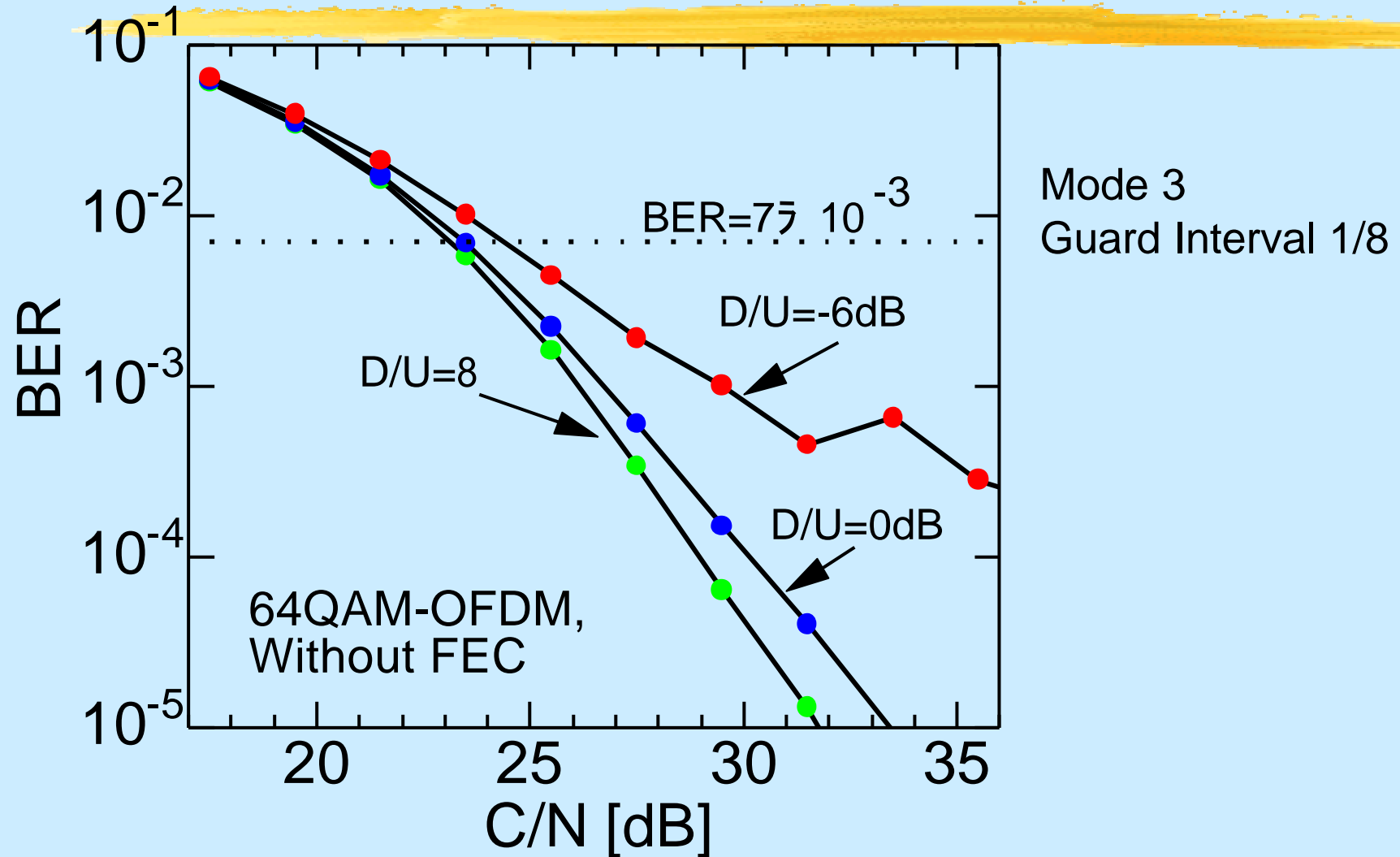


# Principle of Coupling Cancelers

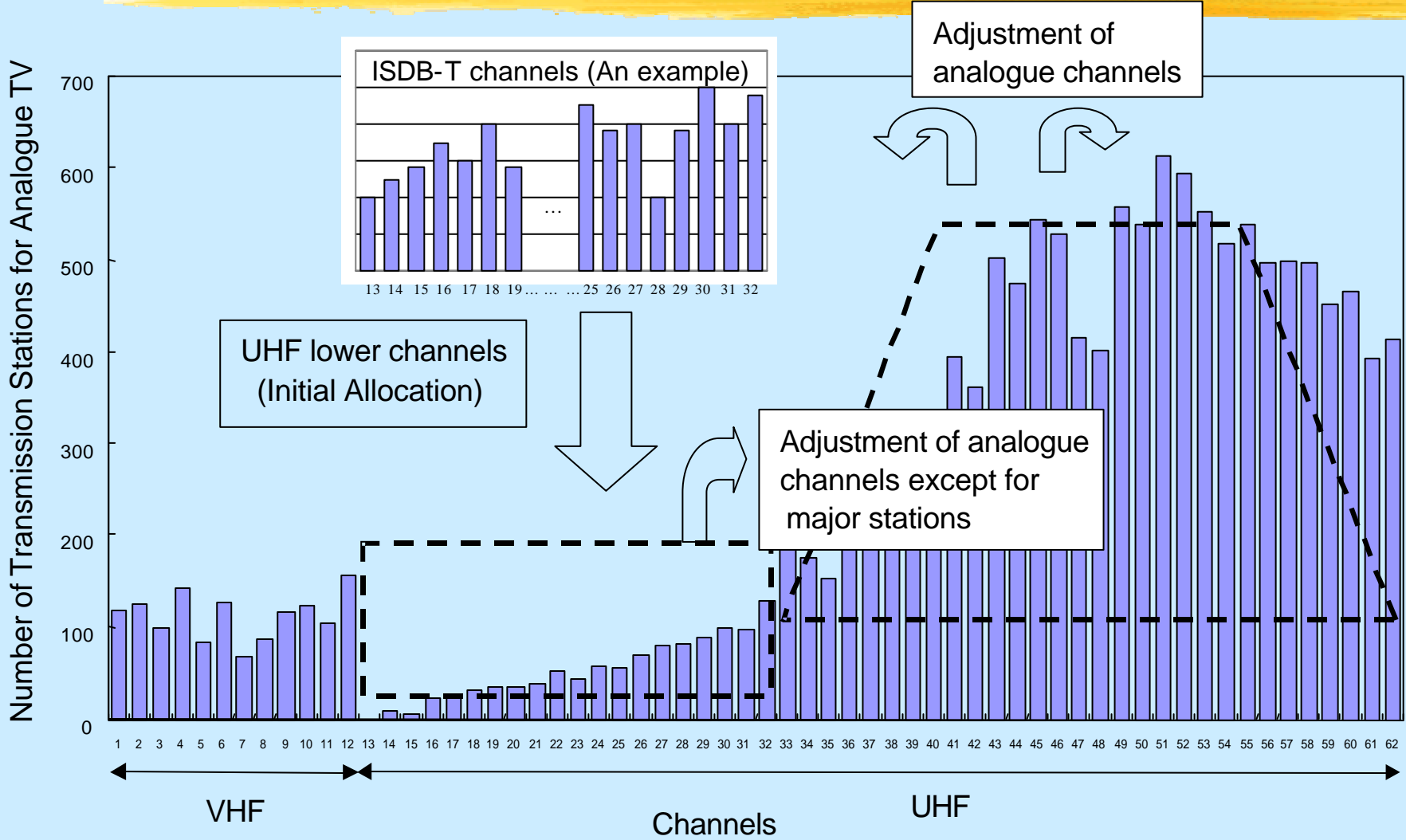


Condition for canceling:  $W(?) = G(?) C(?)$

# Result of Field Trials (Effect of Coupling Cancelers)



# Frequency Allocation in Japan



# Schedule of Channel Planning in Japan



January 1999:

Start of a consortium on channel plan

April 2000:

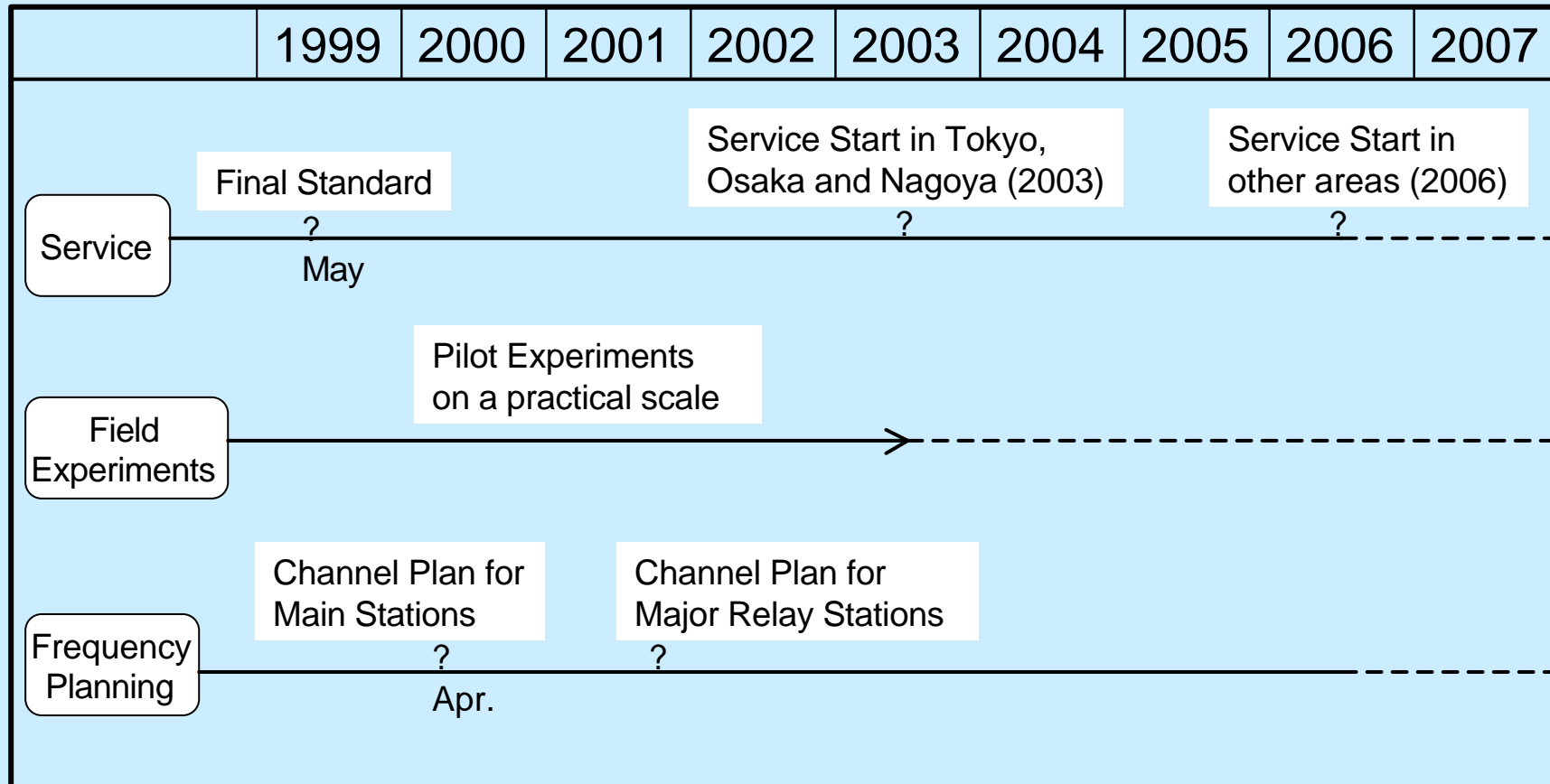
Draft channel assignment for main stations  
all over Japan

By the end of 2001

Draft channel assignment for major relay  
stations



# Schedule of Implementation of ISDB-T in Japan



# Conclusions



- **ISDB-T system based on Band Segmented OFDM was developed in Japan.**
- **The ISDB-T system was standardized as the digital terrestrial television broadcasting system in Japan in May 1999.**
- **Pilot experiments of ISDB-T are carried out in 11 major cities in Japan.**
- **ISDB-T services are planned to start before the year 2003.**