Presentation 2

ISDB-T Transmission Technologies and Emergency Warning System

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DiBEG JAPAN

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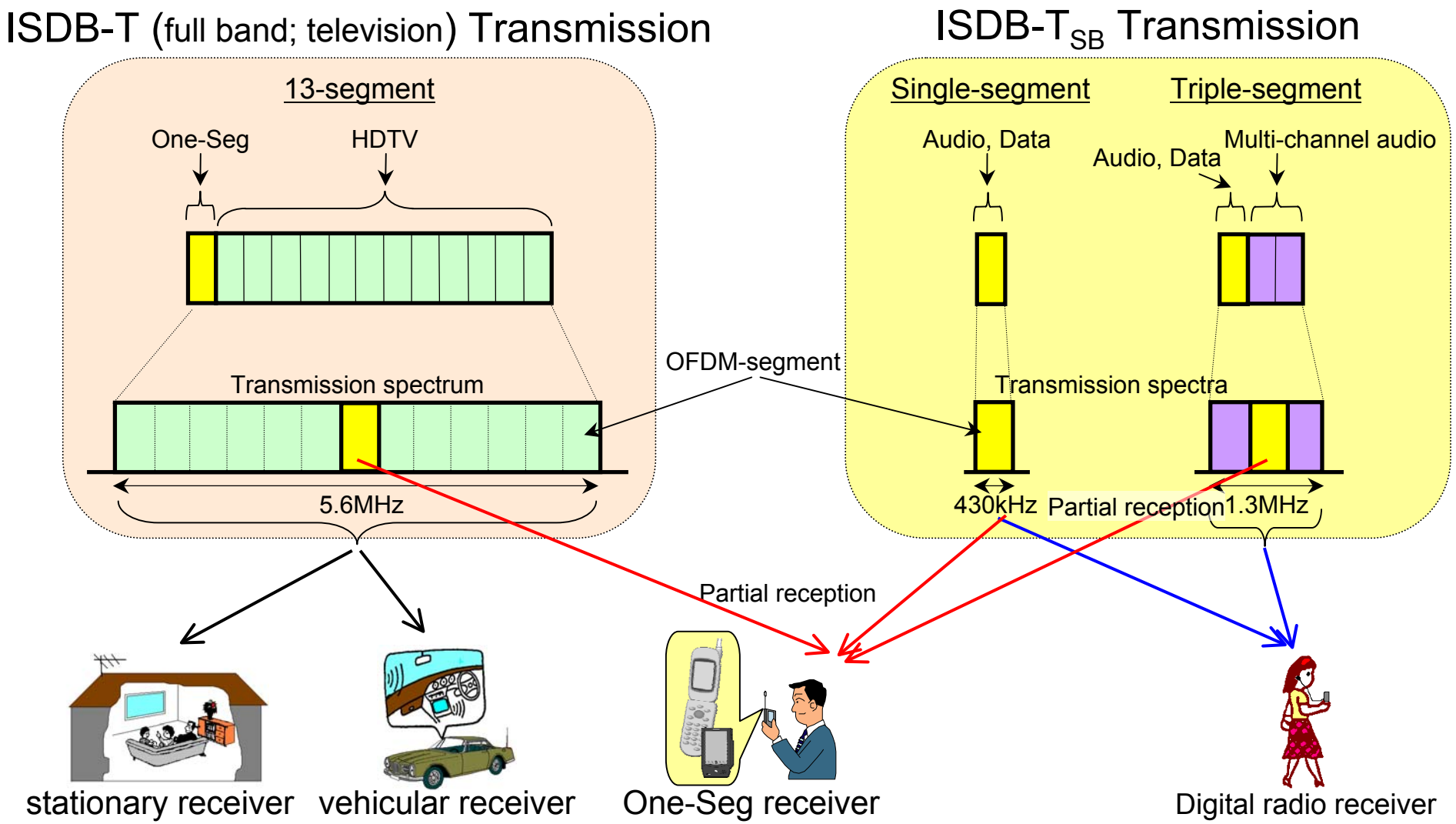
Contents

1. ISDB-T System

Features of ISDB-T system

- ISDB-T has *technological advantage in mobile reception*
- ISDB-T promises *flexible broadcasting services* through hierarchical transmission
- *HDTV* and *mobile service* can be transmitted *simultaneously*
  - ***One-Seg service*** for portable receivers
- *HDTV mobile reception* by diversity reception technology
  - The same HDTV broadcasted for stationary receiver can be viewed in motor vehicle
- *EWS* (Emergency Warning System)
  - Portable receiver woken up by EWS signal alerts you quickly with earthquake and tsunami warning
- *SFN* for effective frequency utilization

ISDB-T transmission concept and its reception



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ISDB-T Services (Fixed and Mobile)

- Digital Terrestrial Television Broadcasting
  - Recommended as **System C of Recommendation ITU-R BT.1306-3**
  - 13 OFDM-segments system
  - HDTV broadcasting
  - One-Seg service (services for mobile reception terminals)
  - Multi-broadcasting (broadcasting plural programs simultaneously)
  - Data broadcasting
  - Engineering services to increase receiver functions and resolve problems by using broadcast waves

- Terrestrial Digital Sound Broadcasting (ISDB-T_{SB})
  - Recommended as **System F of Recommendation ITU-R BS.1114-5**
  - 1 or 3 OFDM-segments system
  - Providing high-quality sound broadcasting and data broadcasting based on text, still pictures, simplified videos, etc.
  - Compatible with One-Seg service for mobile

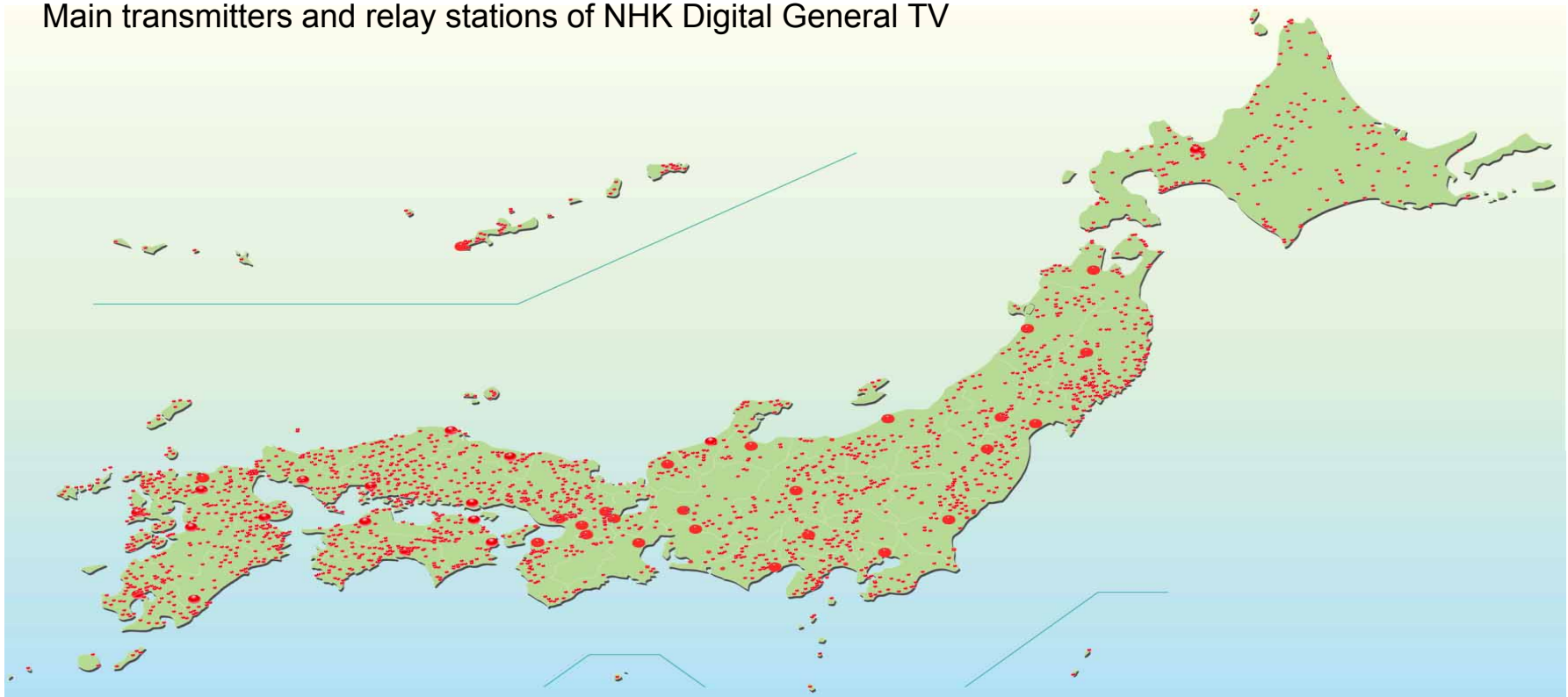
ISDB-T Transmission Scheme, Related ARIB Standards and ITU-R Recommendations

Item			Contents	ARIB Standards	ITU-R Recommendations
Video coding			MPEG-2 Video (ISO/IEC 13818-2)	STD-B32	BT.1208
Audio coding			MPEG-2 AAC (ISO/IEC 13818-7)	STD-B32	BS.1115
Data broadcasting			BML (XHTML), ECMA Script	STD-B24	BT.1699
Multiplex			MPEG-2 Systems (ISO/IEC 13818-1)	STD-B10, STD-B32	BT.1300, BT.1209
Conditional access			Multi 2	STD-B25	—
	Transmission		ISDB-T transmission	STD-B31	BT.1306 System C
	Channel Bandwidth		6MHz, 7MHz, 8MHz		
	Modulation		Segmented OFDM (13 segment / ch)		
	Mode, guard		Mode : 1, 2, 3 Guard Interval ratio : 1/4, 1/8, 1/16, 1/32		
	Carrier Modulation		QPSK,16QAM,64QAM, DQPSK		
	Error correction	Inner	Convolutional code (Coding rate : 1/2, 2/3, 3/4, 5/6, 7/8)		
		Outer	(204,188) Reed-Solomon code		
	Interleave		Frequency and time interleave Time interleave : 0 - 0.5 sec		
	Information bit rate (depends on parameters)		6MHz : 3.7 – 23.2 Mbit/s 7MHz : 4.3 – 27.1 Mbit/s 8MHz : 4.9 – 31.0 Mbit/s		
Receiver			ISDB-T receiver	STD-B21	—
Operational guideline			ISDB-T broadcasting operation	TR-B14	—

2. DTTB Implementation in Japan

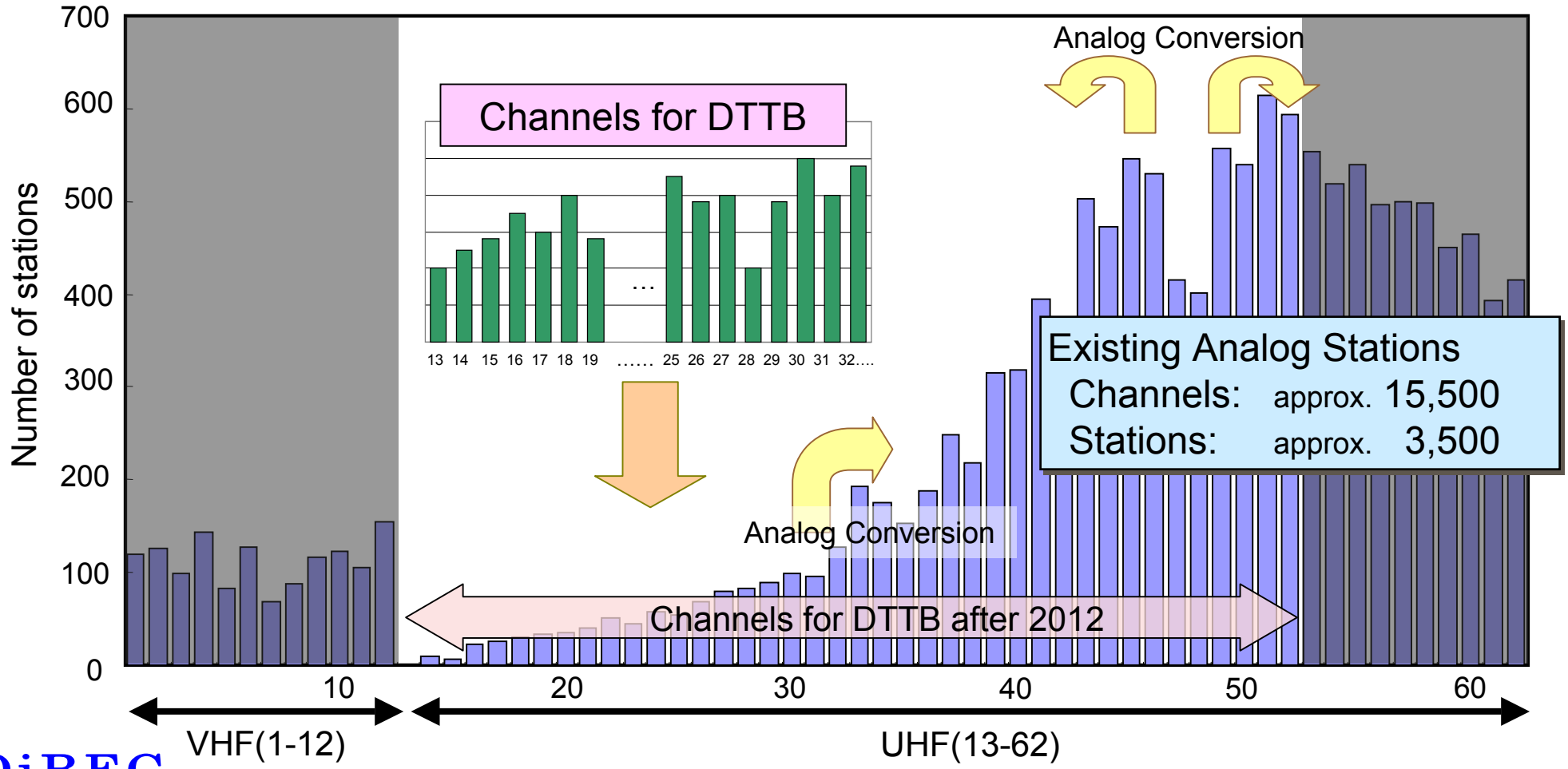
DTTB Transmission

- Distribution of DTTB signals throughout Japan
  - Requires a large number of relay stations.
  - ➢ The equipment cost has become a serious issue.



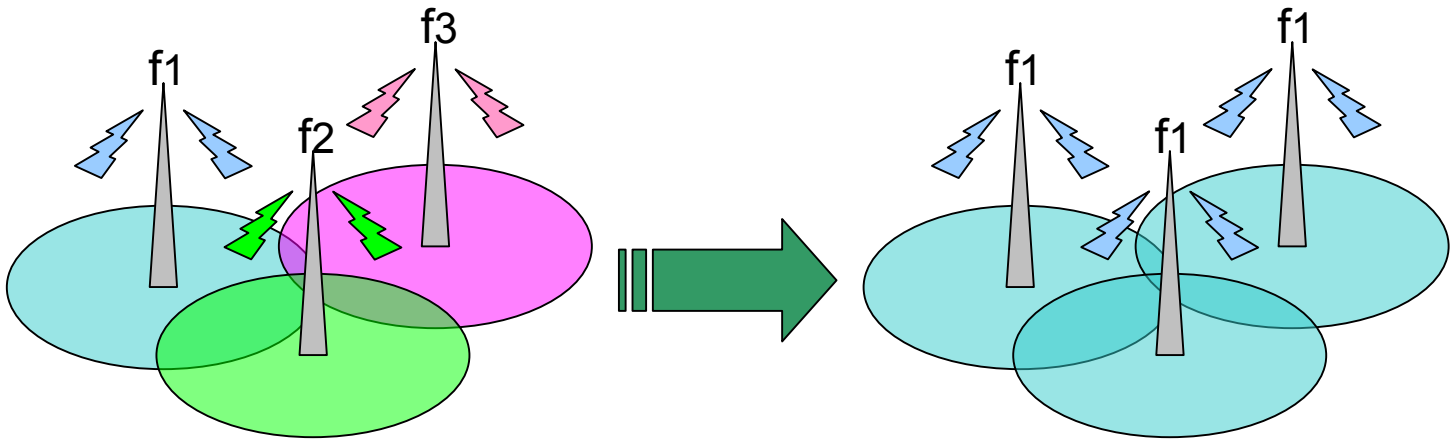
Channel Assignment Plan

- There are not enough channels for DTTB in Japan.
  - SFN (single frequency network) operation is required.

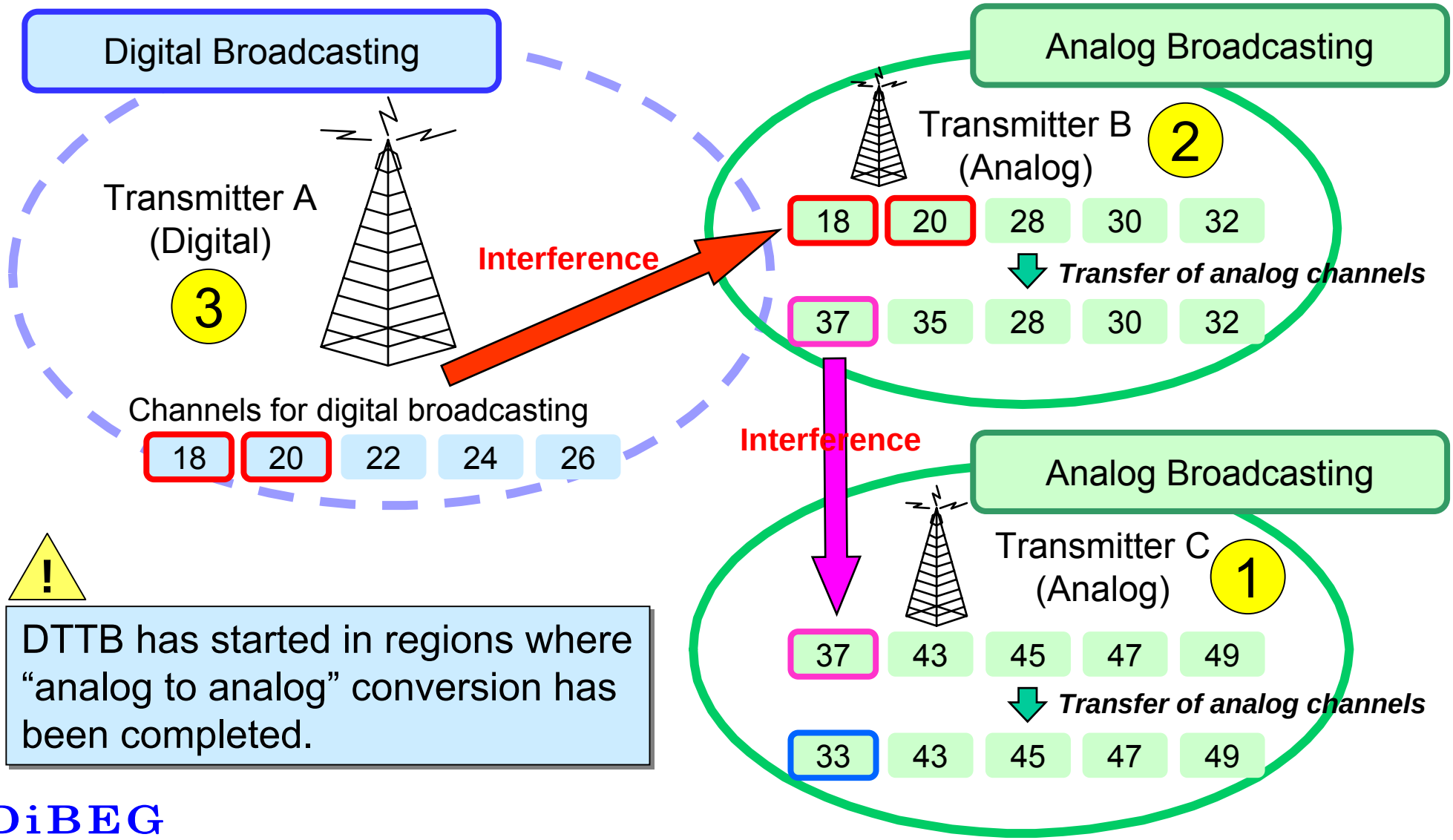


SFN: Single Frequency Network

- ISDB-T enables SFN
  - Addition of guard interval of OFDM
    - Robustness to multipath interference
  - Effective utilization of frequency resources



“Analog to Analog” Conversion



DTTB has started in regions where “analog to analog” conversion has been completed.

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Criteria for DTTB Coverage Planning

- Fixed reception (HDTV)
- 64QAM with rate 7/8 error coding
- 60dBμV/m for broadcasting coverage
- Interference protection ratio

Desired	Interference	Lower adjacent channel	Co-channel	Upper adjacent channel
Analog	Analog	10dB	28dB	0dB
	Digital	0dB	45dB	10dB
Digital	Analog	-21dB	30dB (20dB)*	-24dB
	Digital	-26dB	28dB	-29dB

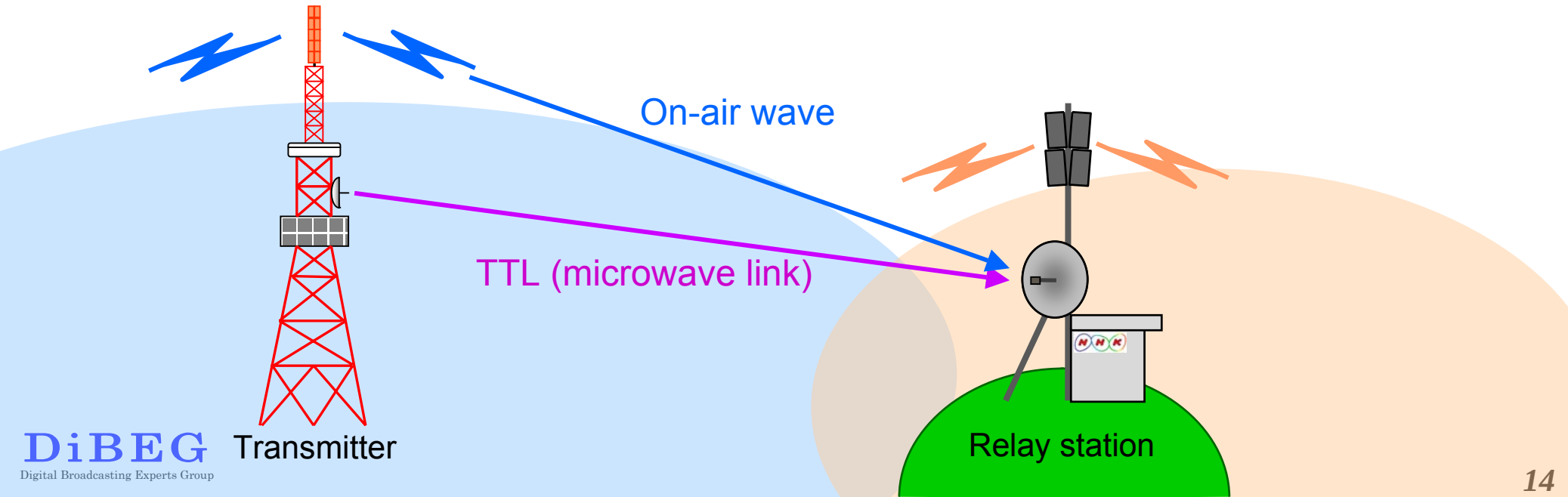
*for improved receiver

3. Broadcast-wave Relay Technologies

Toward the Construction of Countrywide Digital Terrestrial Television Broadcasting Network

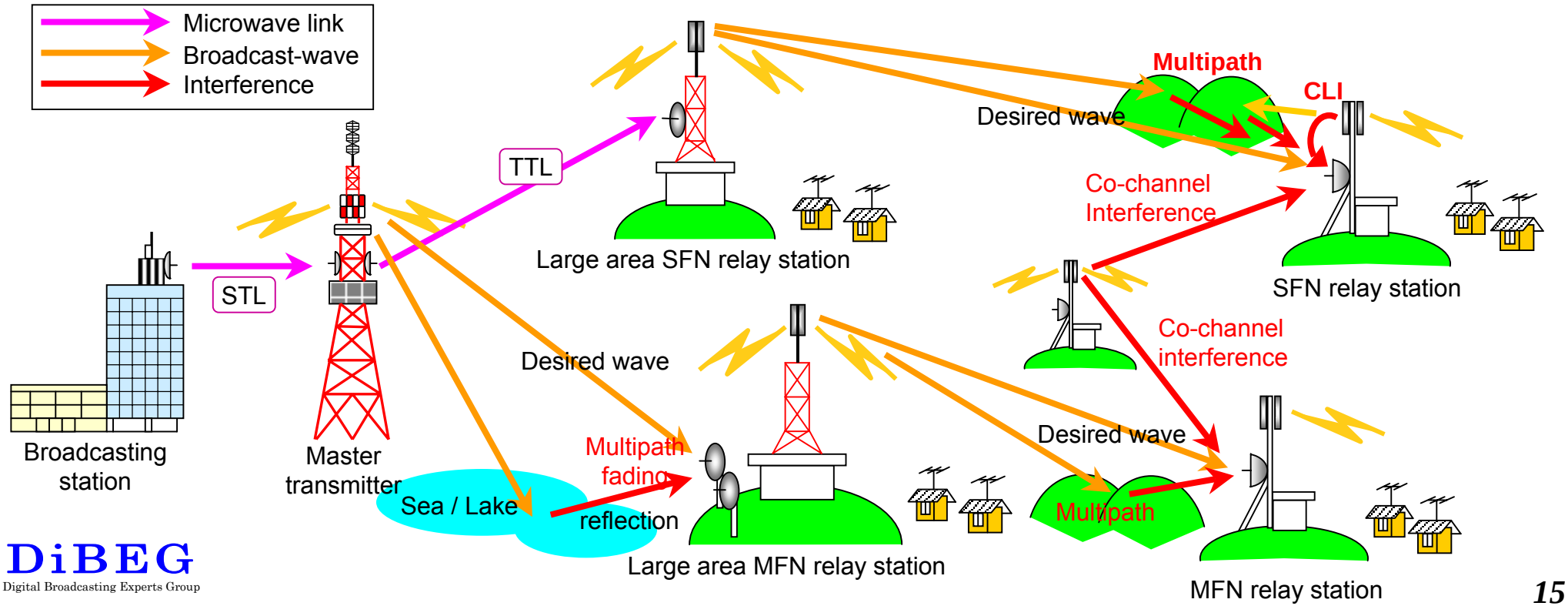
Broadcast-wave Relay (On-air Relay)

- Broadcast-wave relay
  - On-air wave from a station of the previous stage is received and retransmitted by a broadcast-wave relay station.
  - It is the same method as conventional analog broadcasting.
- An on-air relay has the advantage of lower equipment cost.
  - A dedicated link such as a microwave link is not required.
  - Securing of frequency resources for the dedicated link is also not required.



Problem in Broadcast-wave Relay

- Interferences mixed in reception at relay station:
  - Multipath
  - Fading
  - Co-channel interference (analog / digital) from other stations
  - CLI (coupling loop interference; feed back loop) in SFN relay



Compensation Technologies to Address Interferences

Compensation technology	Interference at relay station			
	Multipath	Fading	Co-channel Interference	Coupling Loop Interference
Multipath Equalizer	○	×	×	×
Diversity Reception	◎	◎	×	×
CLI Canceller (On-channel Repeater)	○	×	×	◎
Adaptive Array Antenna	◎	◎	◎	×

◎: excellent, ○: good, ×: ineffective

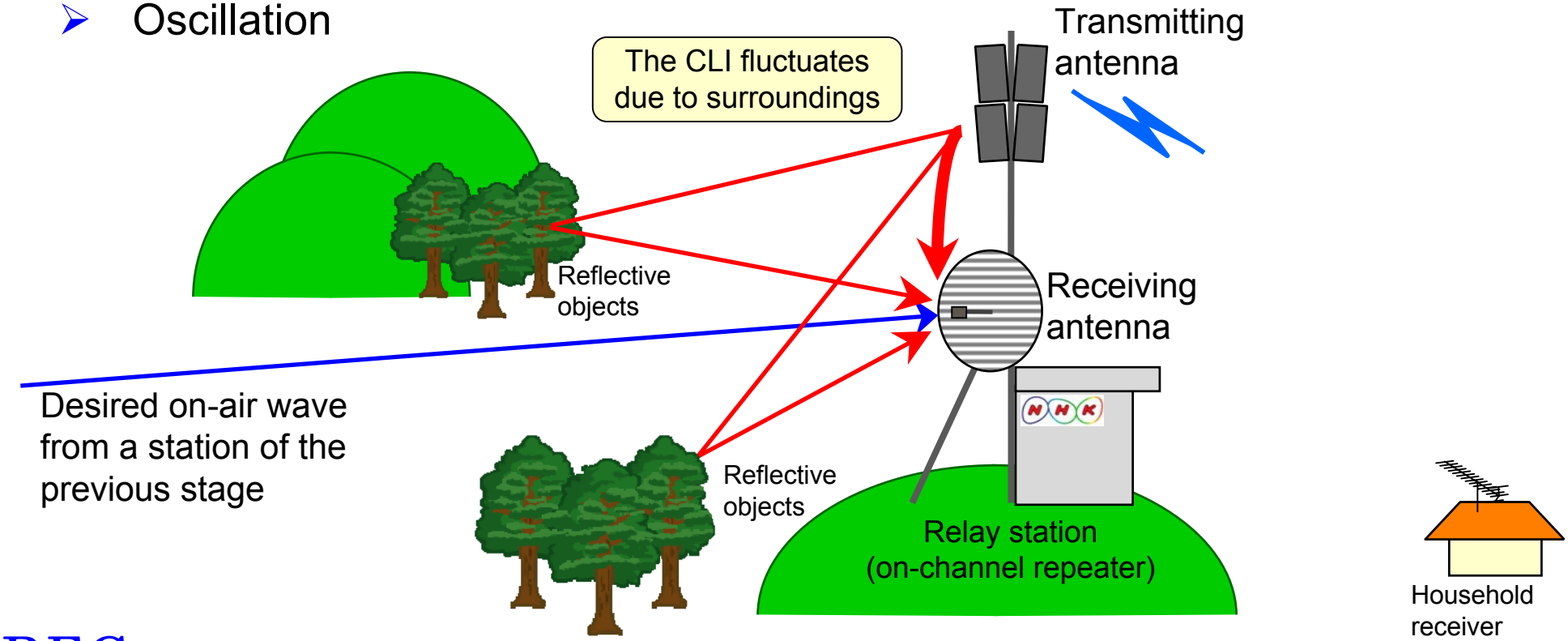
Major Problem of On-channel Repeater

- Problem of coupling loop interference (CLI).

  = Howling of radio wave

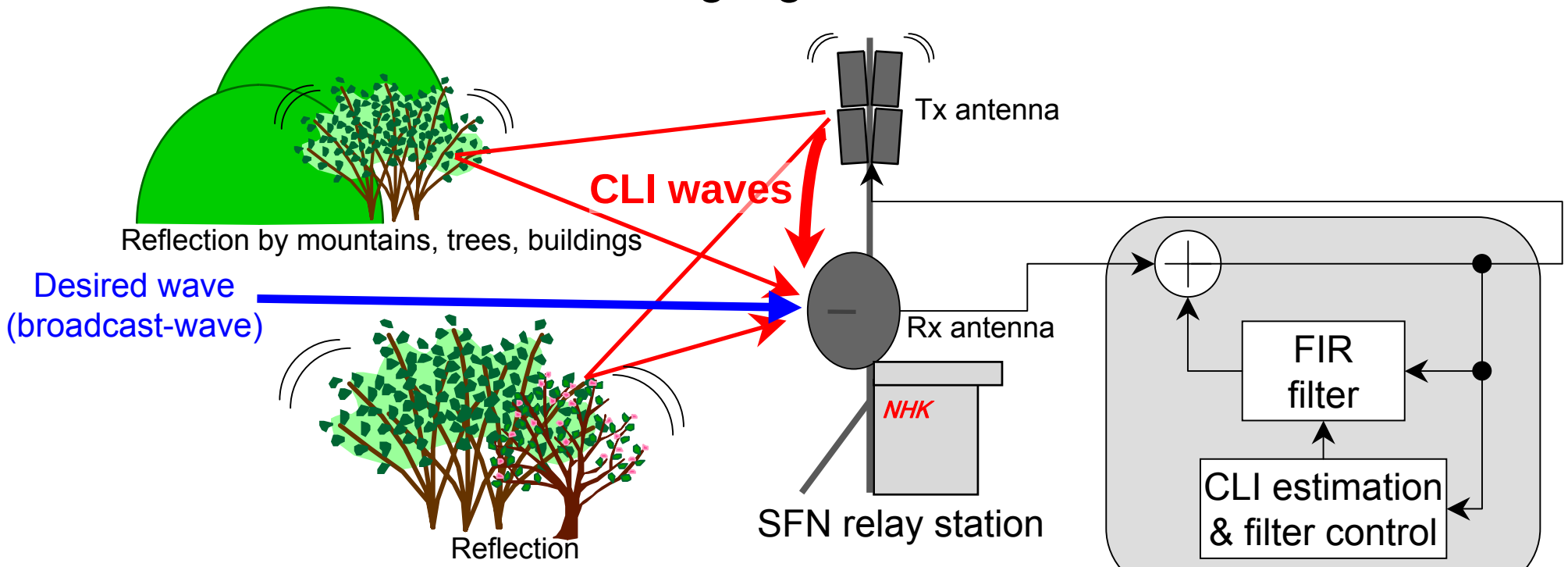
  - Signal degradation
  - Oscillation

→ CLI Canceller

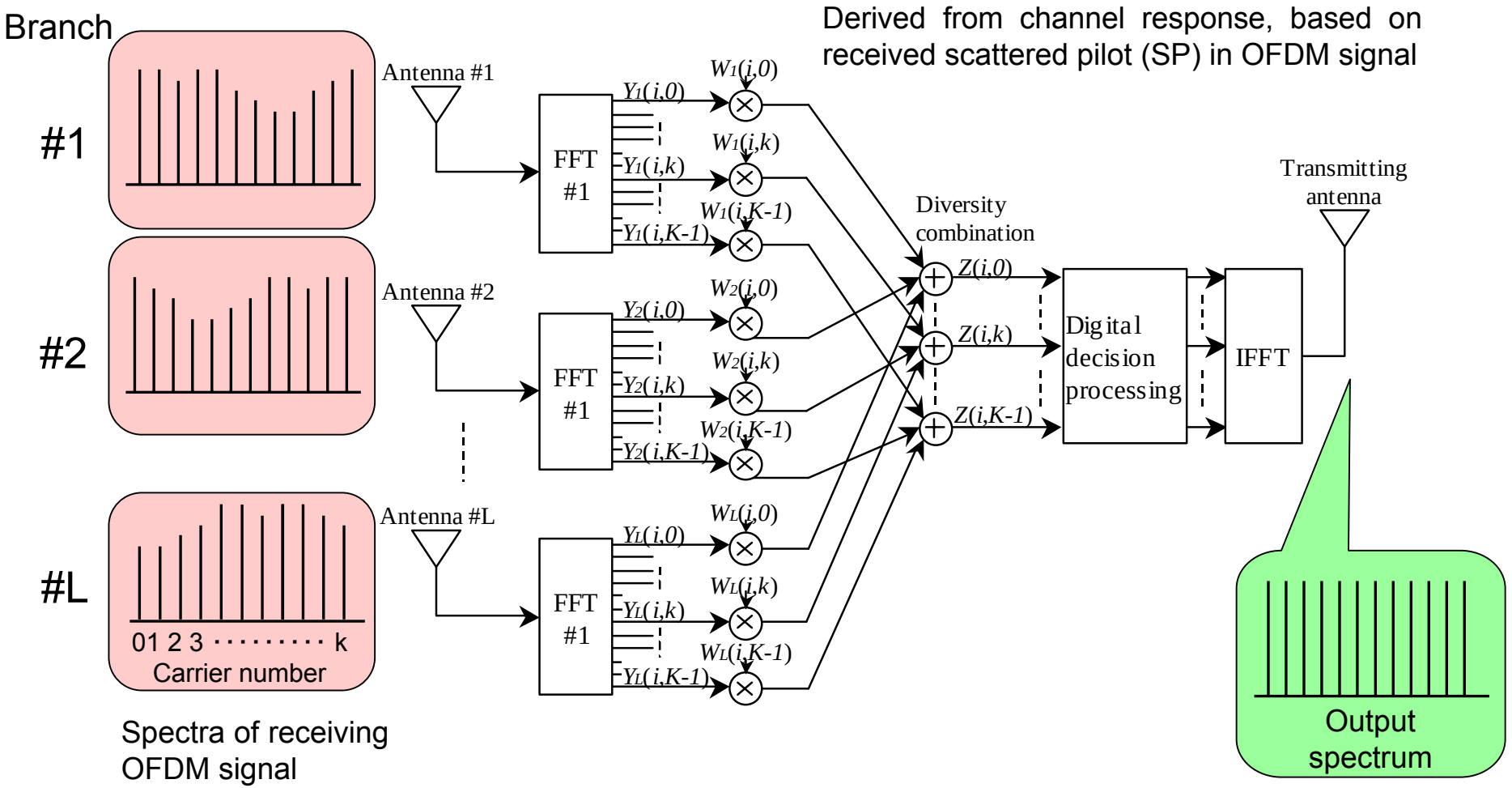


CLI canceller

- Enables single frequency re-transmission (SFN relay)
- Adaptive cancelling algorithm with digital signal processing
- Estimates CLI characteristic, generate CLI replica and cancels CLI from receiving signal

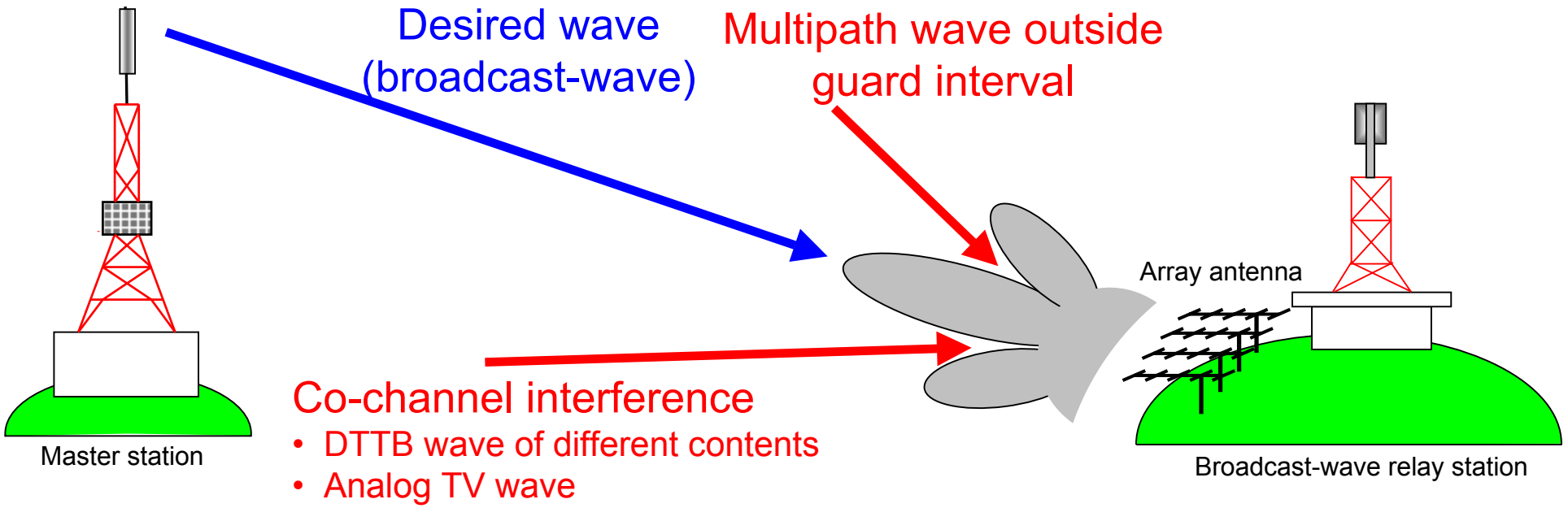


Diversity Reception for Broadcast-wave Relay Station



Block diagram of diversity reception system

Adaptive Array Antenna System for Co-channel Interference



- **Adaptive array antenna system with digital signal processing**
- Eliminates the co-channel interference utilizing the difference in the arrival directions of desired wave and undesired interference

4. ISDB-T Receiver Technologies

HDTV Mobile Reception Technology for ISDB-T

- Conventional reception
  - Robust modulation (16QAM ½ or QPSK)
  - 1 receiving antenna
  - SDTV

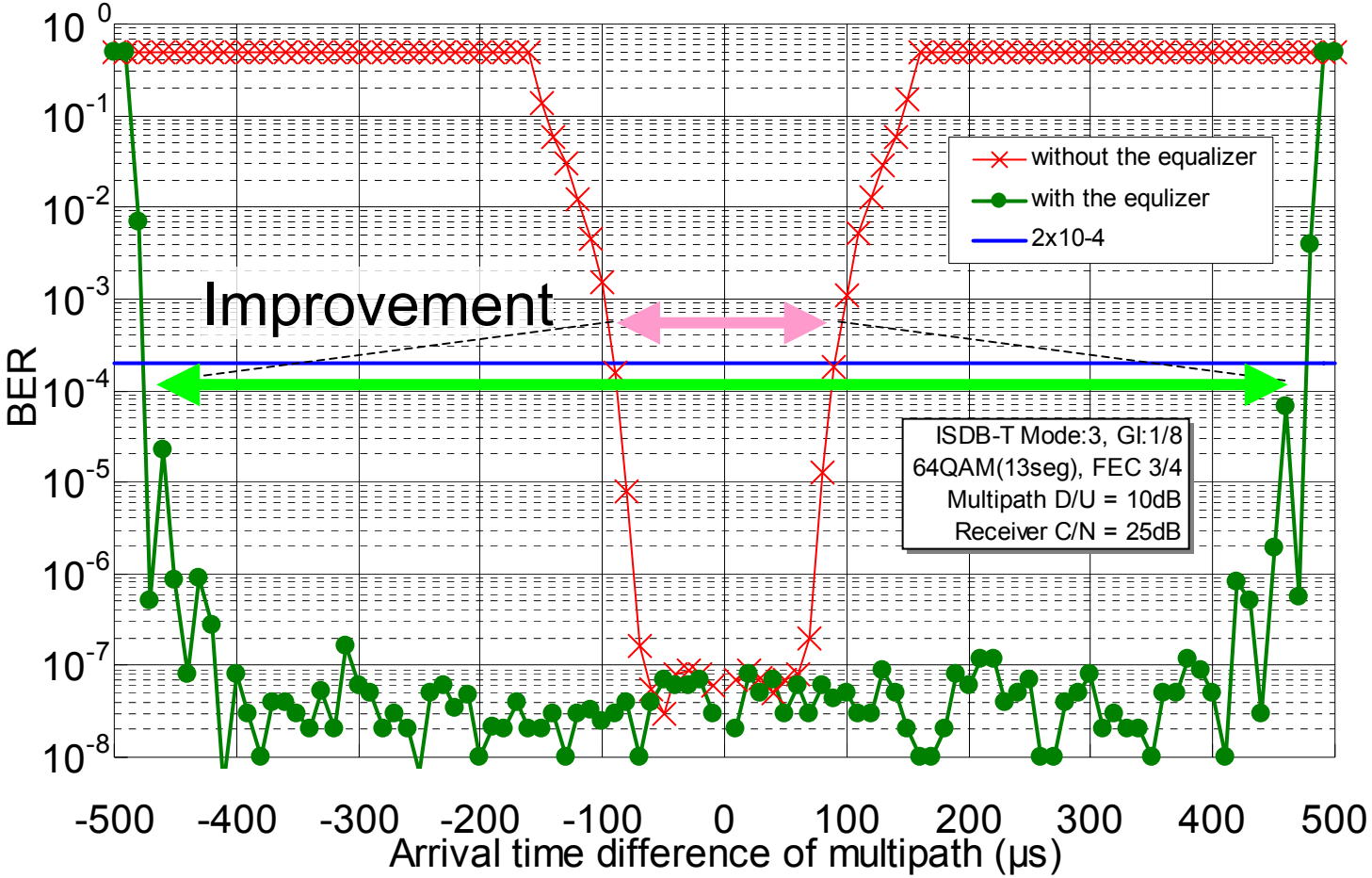
- HDTV mobile reception (diversity reception)
  - 64QAM (transmission same as in stationary reception)
  - 2-4 branches (number of receiving antennas)
  - **HDTV**

- Diversity reception technology for motor vehicles
  - Space diversity
  - HDTV programs are available in a vehicle with high quality, clear and noiseless image
  - A car HDTV system based on the diversity reception technology is already on sale in Japan

Already on sale in Japan

Channel Equalizer for Multipath Interference outside the Guard Interval of OFDM

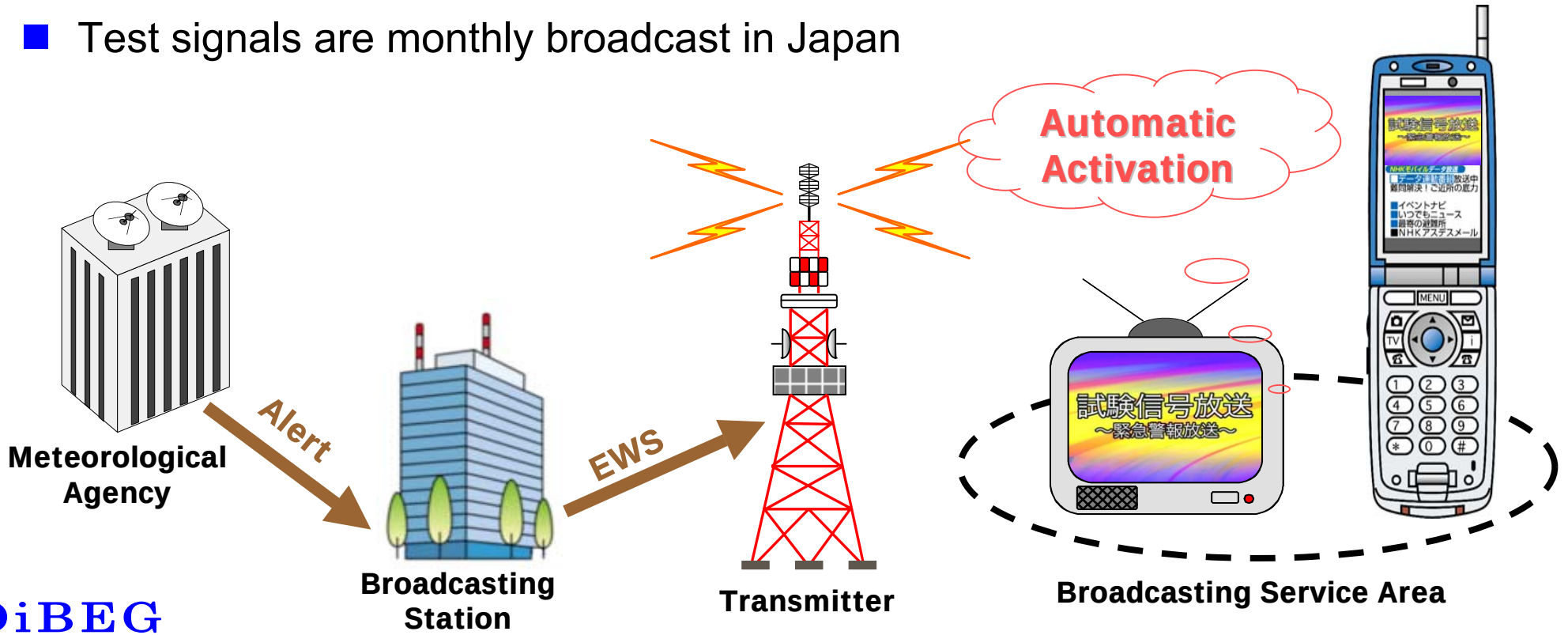
- This technology enables to equalize multipath outside the guard interval (GI) of OFDM.



5. Emergency Warning System for Broadcasting

Emergency Warning System for Broadcasting

- Remote activation of Radio & TV ready for EWS
  - AM, FM Radio & TV : Control and Alert Sound
  - Digital Broadcasting (ISDB-T) : Emergency Warning Control Flag
- EWS has been operated since September 1985 in Japan
- Test signals are monthly broadcast in Japan



List of Recent Significant Earthquakes (from December 2004)

Date	Place	Fatalities	Magnitude
Dec. 26, 2004	Off northwest coast of Sumatra, Indonesia	300,000	9.3
Feb. 22, 2005	Zarand, Iran	Over 500	6.4
Mar. 28, 2005	Northern Sumatra, Indonesia	1,000-2,000	8.7
Oct. 8, 2005	Kashmir, Pakistan	100,000 (estimated)	7.6
May. 26, 2006	Java, Indonesia	Over 6,000	6.3
July. 17, 2006	Java, Indonesia	Over 500	7.7

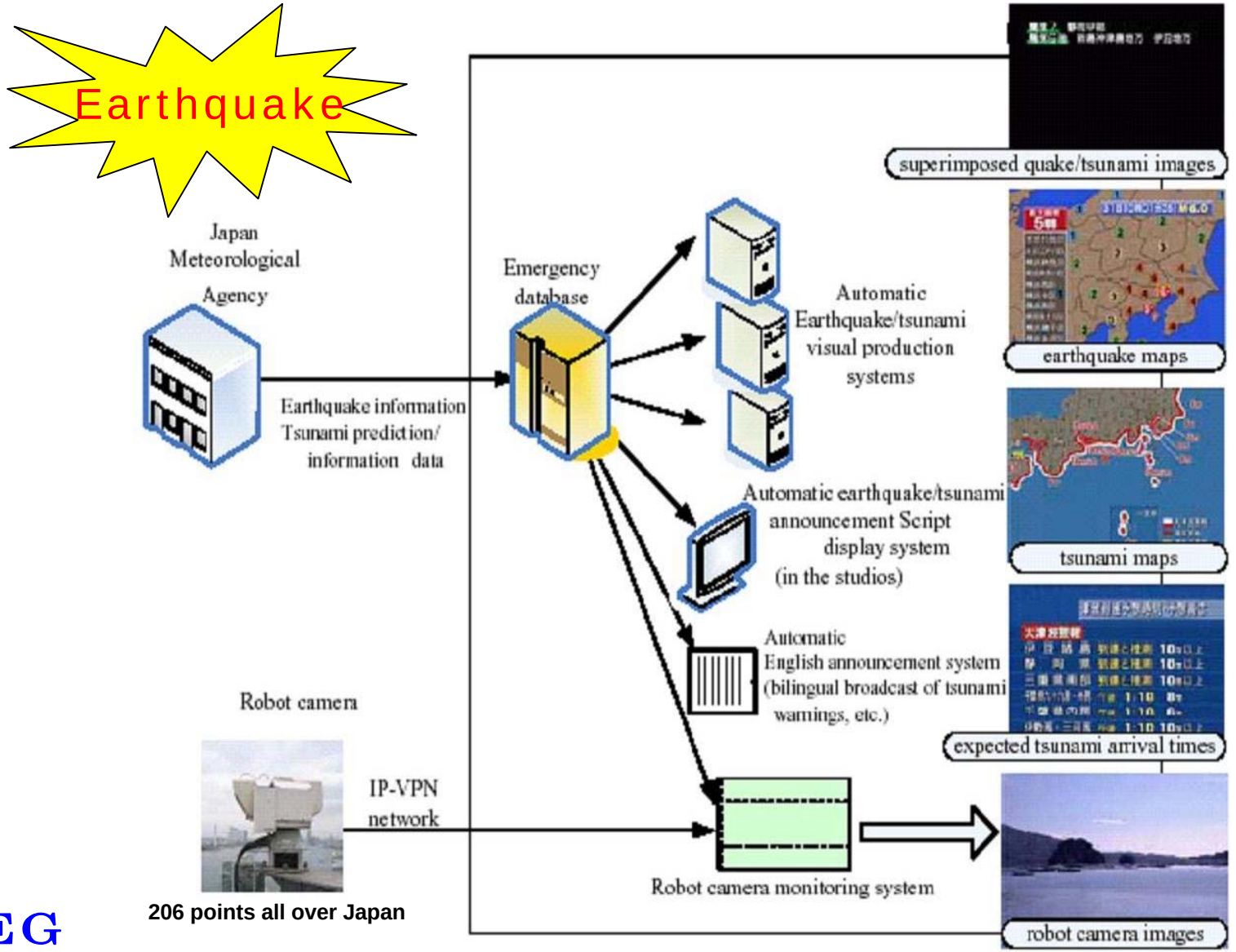
Functions of Broadcasting in Disaster Management

- Gathering/receiving disaster information from administrative organizations
- Filtering information
- Delivering disaster information to the general public

- Broadcasting offers reliable information
  There are no “spam” information in broadcasting
- Always connected to everybody
  There are no congestions like in communication
- Always active : 24 hour operation

- Broadcasting is an ideal media to deliver disaster information

Connection of Emergency Information



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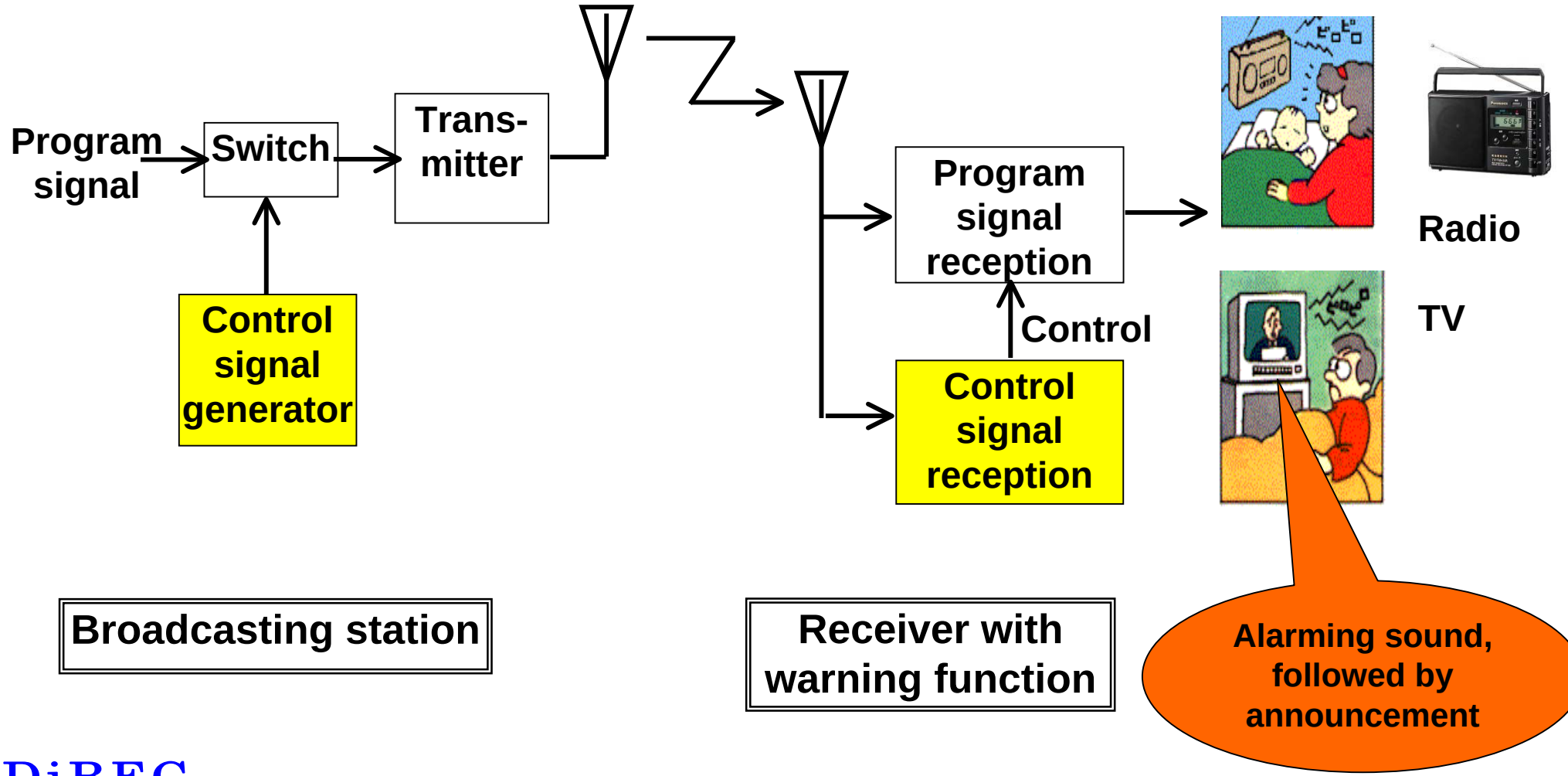
History of EWS for Broadcasting in Japan

- 1980 Start of EWS study
- Sep.1,1985† Start of EWS in Japan
- Mar.18,1987 First EWS operation for tsunami warning
- Jan.13,2007 Latest EWS operation for tsunami warning
- Up to now 15 times EWS operation during 21 years

† On September 1, 1923, a big earthquake attacked Tokyo area and more than 100 thousand people died. It became a trigger to start radio broadcasting in Japan. September 1st is Disaster Prevention Day in Japan.

EWS for Analog Broadcasting Transmission and Reception



EWS for Analog Broadcasting Conventional Receivers

Receiver with a Clock

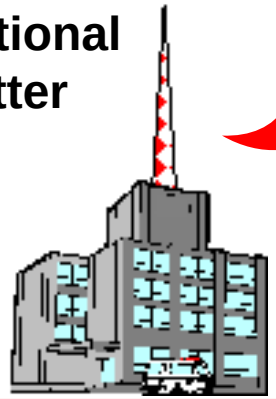
Portable AM/FM Receiver

Receiver with Power on switch

…were not cost-effective

EWS for Analog Broadcasting
Low Cost EWS Implements

Conventional transmitter



Compact Disc in which EWS signals are recorded

Enough for sending EWS

Conventional Receiver ($2)

Speaker

EWS Adaptor IC* parts: ($1)

*TI MSP430

Enough for receiving EWS

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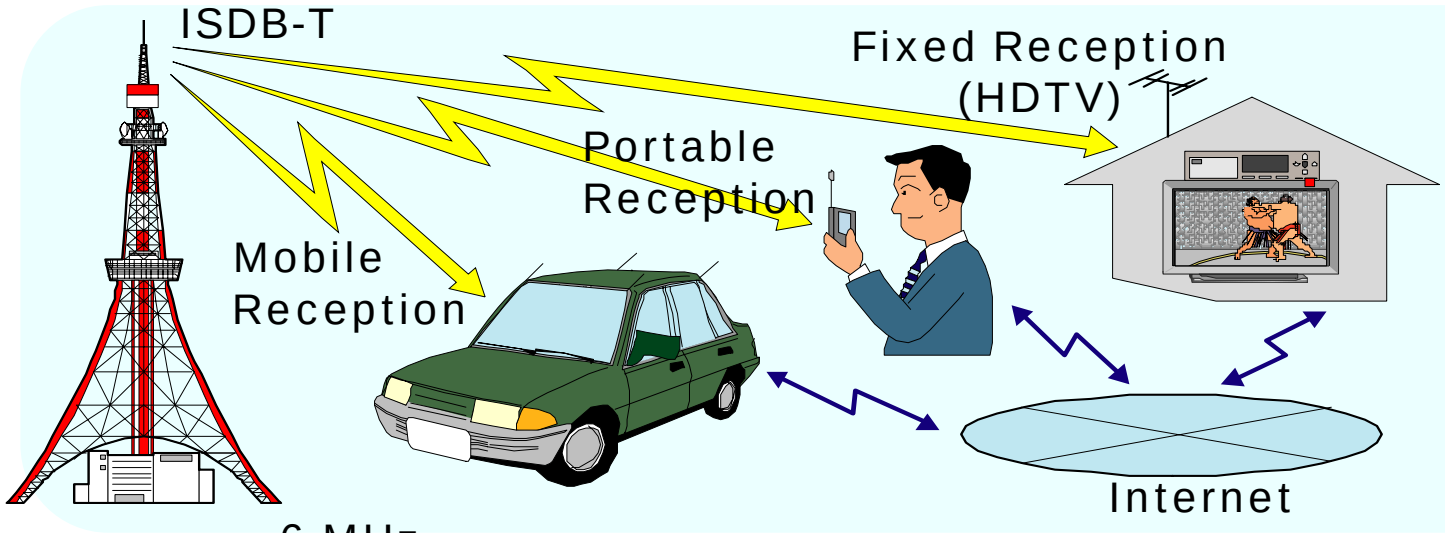
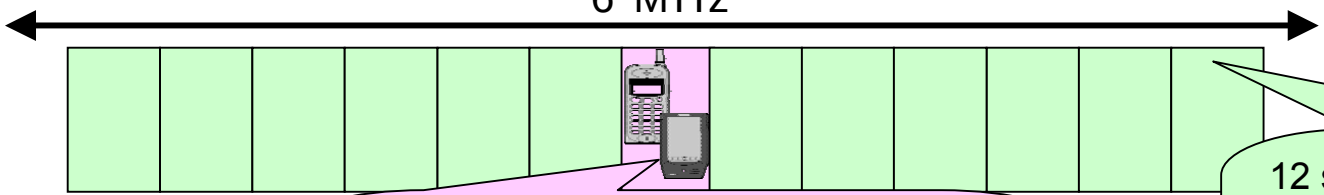
EWS for Digital Broadcasting
ISDB-T One-Seg Services

- A channel slot divided into 13 segments
  - 12 segments for HDTV services
  - 1 segment for mobile / portable services
- Both services are simulcast now.





1 segment: Mobile Portable Reception
Modulation: QPSK (2/3)
Throughput: 416Kbps
Features: Robust for Mobile Reception

12 segments: Fixed Reception (HDTV)
Modulation: 64QAM (r=3/4)
Throughput: 16.9Mbps
Features: HDTV & 5.1ch Surround Audio,
Multi-channel Services

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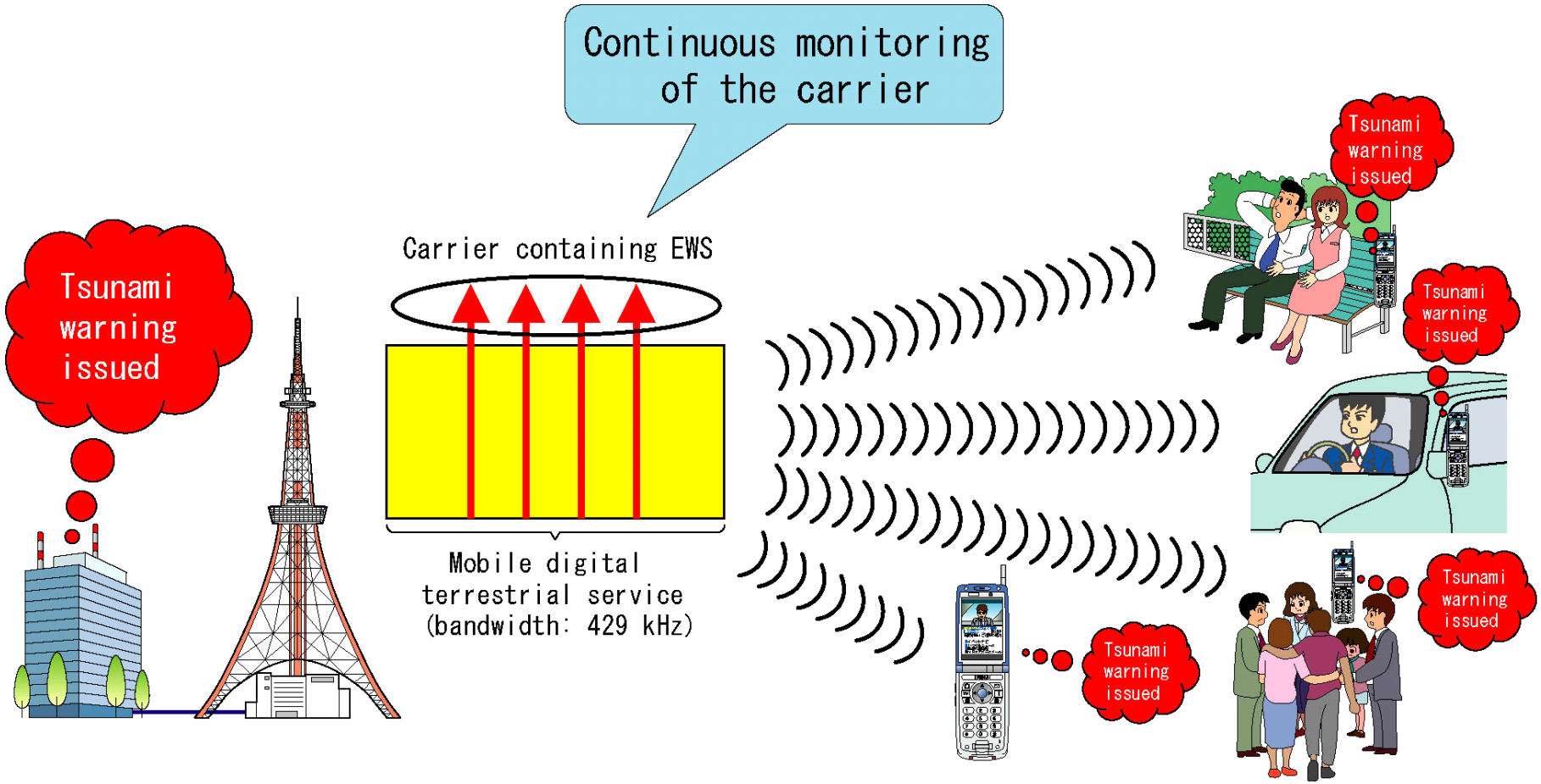
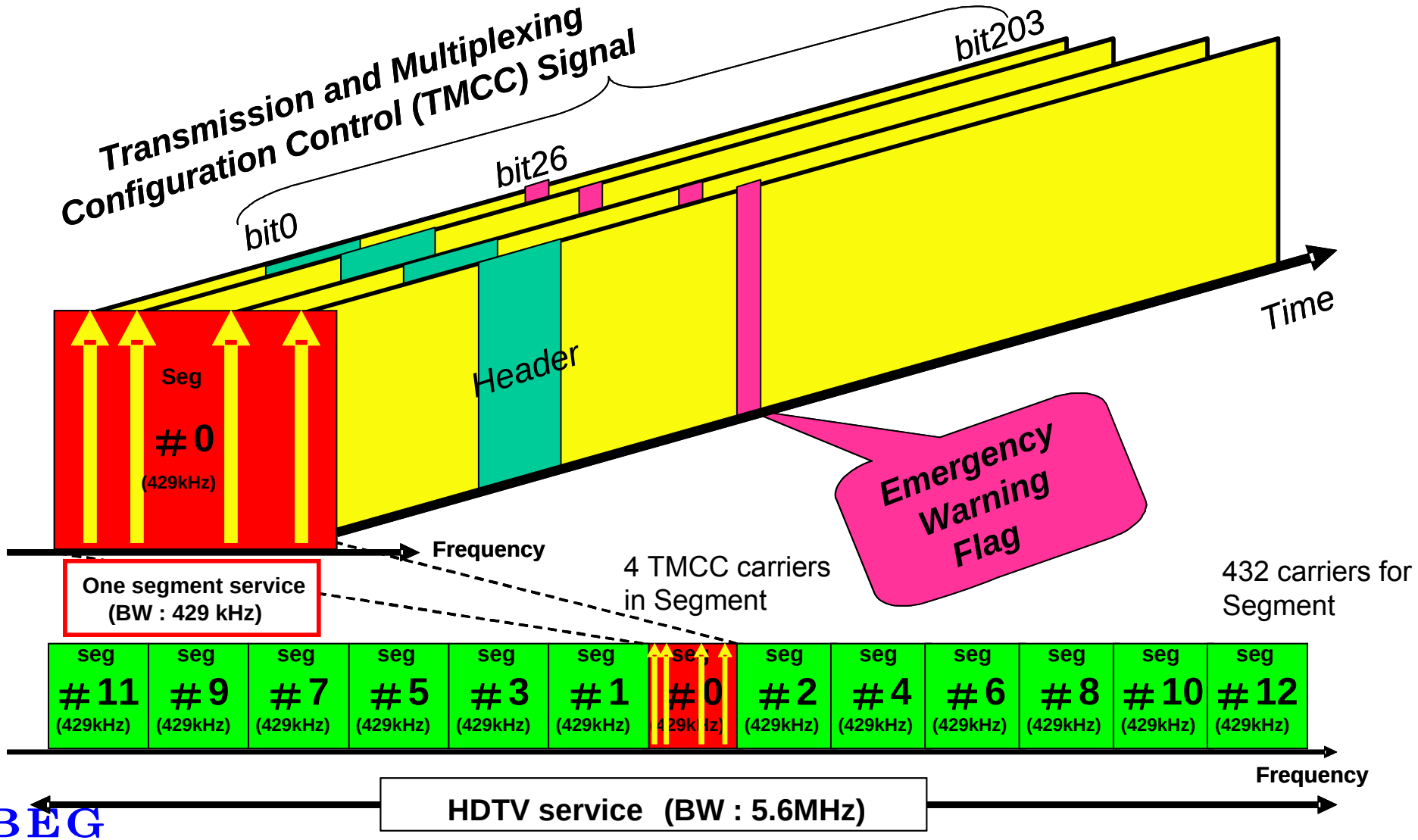
EWS for Digital Broadcasting
EWS for ISDB-T One-Seg Services

- EWS for ISDB systems have already been in operation in Japan as well as analog broadcast
- Portable EWS receivers for One-Seg are now under development
- One-Seg receivers are expected to enlarge the opportunity to avoid disaster
- Technology for saving power consumption is the key
- EWS should be prepared by other digital broadcasting systems

EWS for Digital Broadcasting
Concurrent Mobile Receiver Activation Using EWS



EWS for Digital Broadcasting
EWS Signal Allocation in ISDB-T



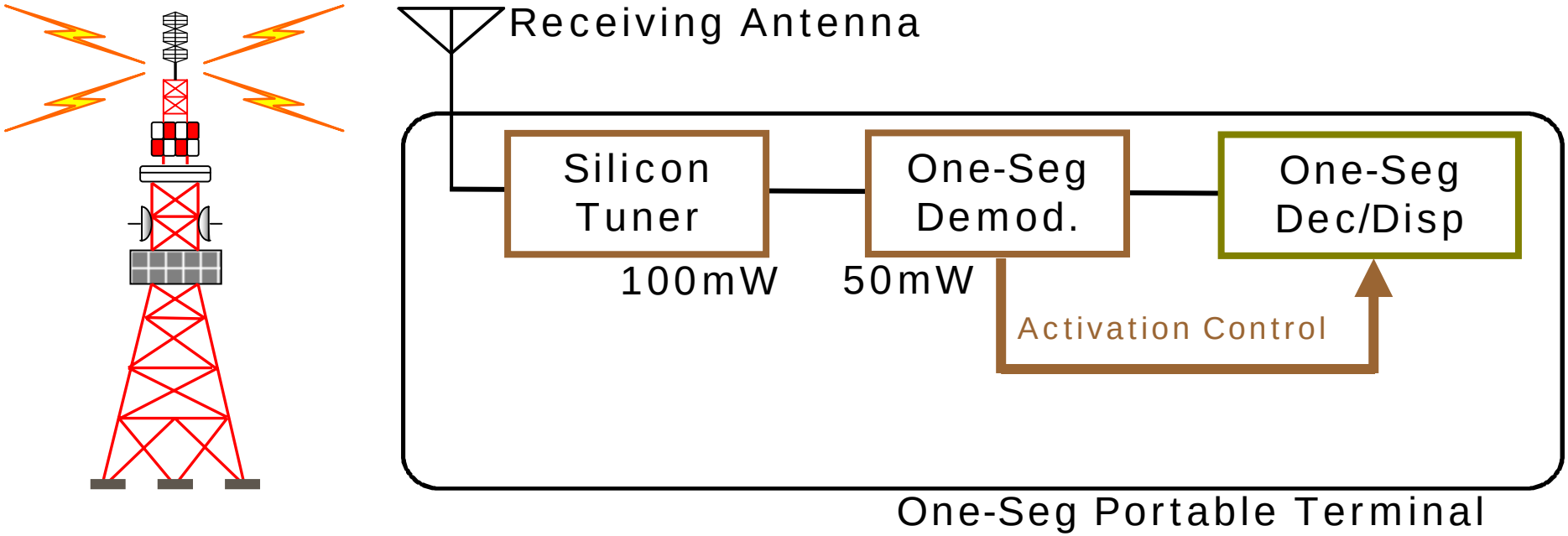
EWS for Digital Broadcasting
ISDB-T One-Seg Services & EWS

- Remote activation of mobile terminals by EWS is very effective.
- EWS bits in TMCC have to be always watched in mobile terminals.

The problem is power consumption of mobile terminals

Power consumption saving is required during EWS stand-by mode

EWS for Digital Broadcasting
Conventional EWS Stand-by

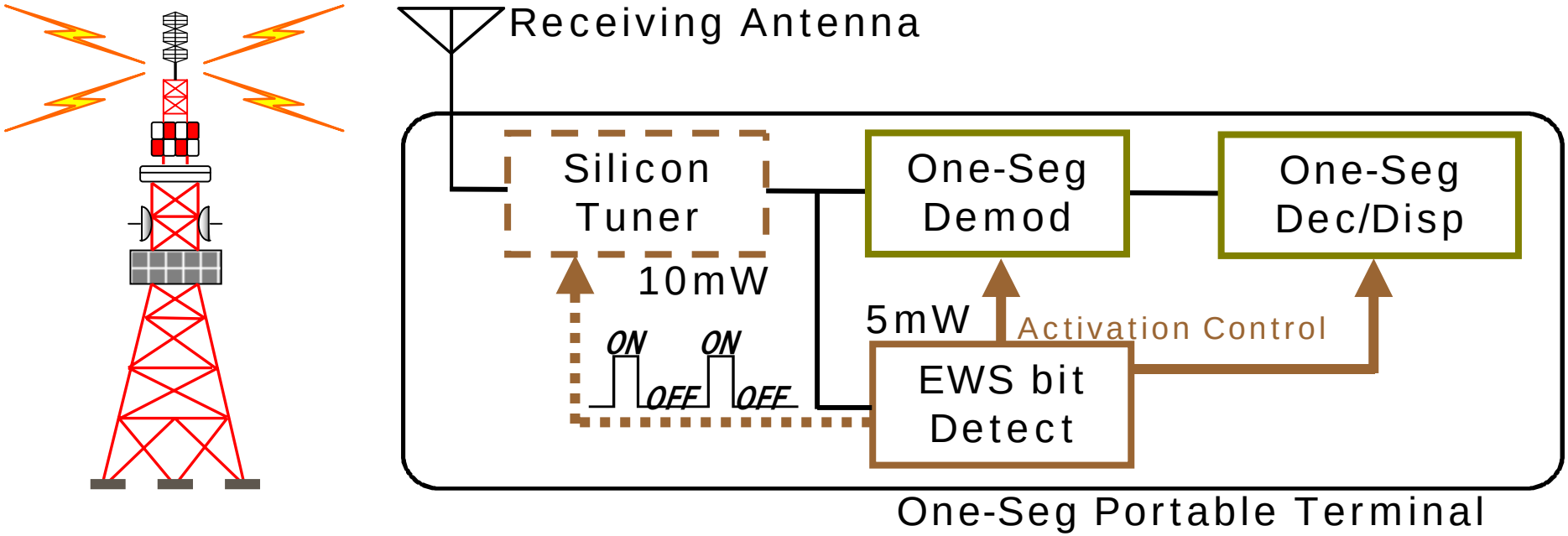


- Silicon Tuner(100mW) and Demodulator(50mW) are always active
- Life of a Battery(3.7V,800mAh≒3Wh) is only 20h(1 day)

↓

More than 200h(8 days) would be required

EWS for Digital Broadcasting
Saving Power Consumption for EWS Stand-by



- Silicon Tuner(10mW) and EWS bit detector(5mW) are active only for necessary duration
- Life of a Battery(3.7V,800mAh≒3Wh) improved to 200h(8.3 days)

EWS Application

Not only

- Tsunami forecast

But also

- Earthquake forecast
- Hurricane forecast
- Flood warning
- Eruption warning
- Fire warning
- Other warning

6. Conclusion

Conclusion (ISDB-T System)

- ISDB-T has *technological advantage in mobile reception*
- *HDTV* and *mobile TV service* (***One-Seg***) can be transmitted *simultaneously*
- *HDTV mobile reception* by diversity reception technology
  - The same HDTV broadcasted for stationary receiver can be viewed in motor vehicle
- *SFN* for effective frequency utilization
- *Broadcast-wave Relay Technologies of ISDB-T* enables low-cost implementation of terrestrial digital broadcasting.
- There are many cutting-edge technologies in ISDB-T system.

Conclusion (EWS)

- *EWS* (Emergency Warning System)
  - Broadcasting is an ideal media to deliver disaster information
  - EWS for broadcasting remotely activates radio and TV ready for the system
  - EWS for analog radio and TV has already been in operation in Japan
- Preparation for EWS toward digital broadcasting
  - Portable receiver woken up by EWS signal alerts you quickly with earthquake, tsunami warning and so forth.
  - Saving power consumption during EWS-stand-by mode is required.
- EWS has been approved as Recommendation ITU-R BT.1774-1

Thank you for your attention!

Koichiro IMAMURA

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http://www.nhk.or.jp/strl/english/