

Presentation 3

***ISDB-T Transmission Technologies
and Emergency Warning System***

A decorative graphic on the left side of the slide, featuring a black crosshair overlaid on a yellow, red, and blue gradient background.

25th. July. 2007

Caracas, Venezuela

DiBEG JAPAN

Masayuki, TAKADA

(NHK, Japan Broadcasting Corporation)



Contents

1. Outline of ISDB-T

2. ISDB-T transmission system

- Requirements and features, transmission technology, parameters, ISDB-T standard

3. Comparison of 3 DTTB systems

- Features of 3 DTTB systems and comparison test results

4. Emergency Warning System for ISDB-T

- EWS and key technology for power saving

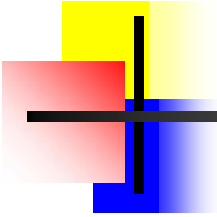
5. Conclusions

What is ISDB-T ?

ISDB-T is ...

- ***One of the DTTB system in the world***
 - There are 3 systems recommended in ITU-R BT1306.
 - ISDB-T, DVB-T and ATSC
- ***The most flexible system***
 - HDTV, multi-SDTV, EPG, data-casting, internet-access, mobile reception, Cellular phone TV, etc.
- ***The most robust system***
 - OFDM, time-interleaving, etc.
 - Brazilian comparison test results proved it.
- Developed in Japan

2. ISDB-T transmission system

- 
- A decorative graphic on the left side of the slide, featuring a yellow square at the top, a red square to the left, and a blue square at the bottom, with a black crosshair overlaid.
- Requirements for DTTB
 - Transmission technologies
 - Technical features of ISDB-T
 - ISDB-T standard

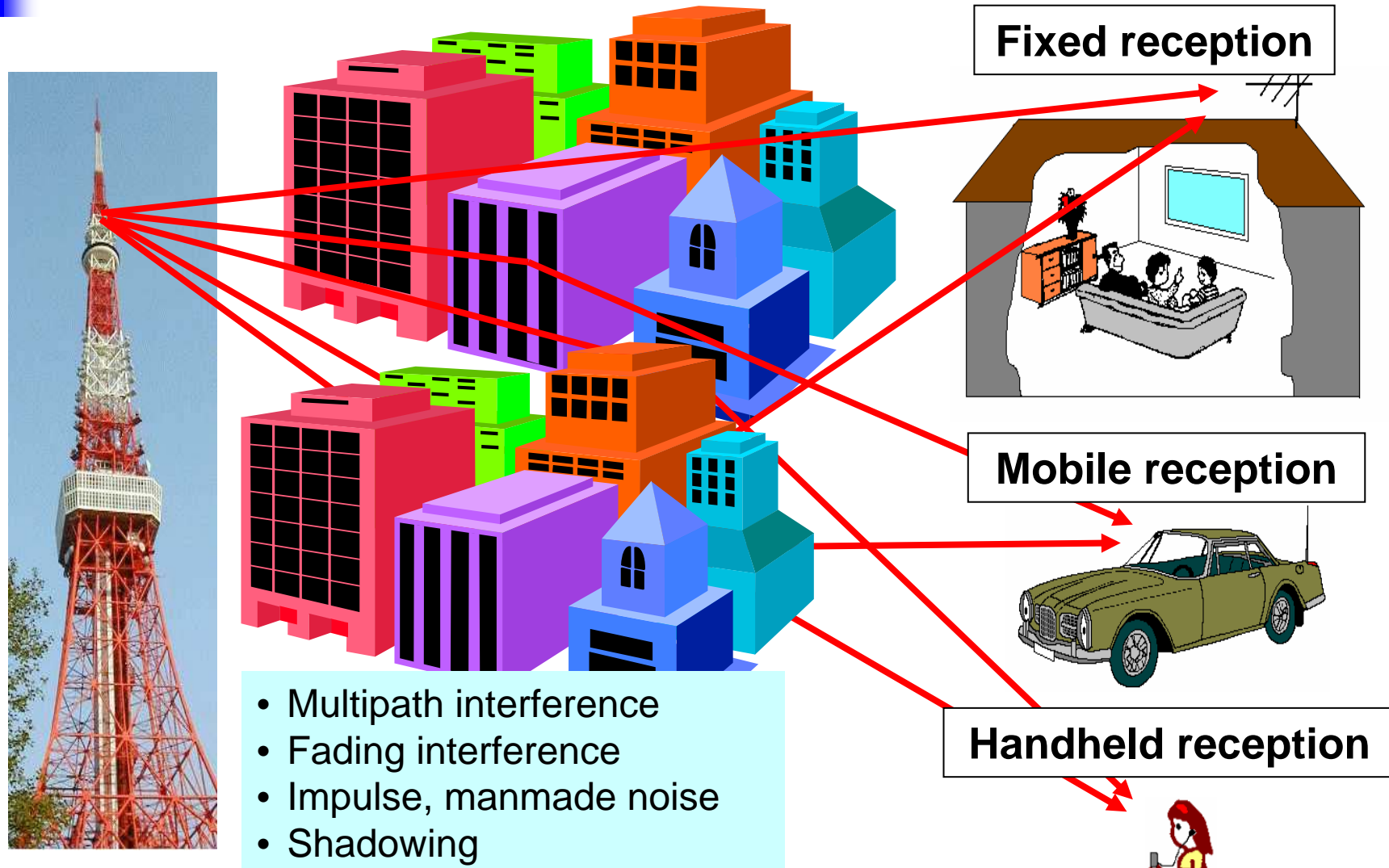
***DTTB** (Digital Terrestrial Television Broadcasting)*

***ISDB-T** (Integrated Services Digital Broadcasting - Terrestrial)*

Requirements for DTTB

- ***Attractive broadcasting service***
 - High quality TV and sound (HDTV, 5.1 surround)
 - Anytime information access (Data, Internet)
 - Robustness against interference
- ***Mobile and portable reception***
 - Anytime, anywhere TV service
- ***Effective Frequency Utilization***
 - Frequency congestion in VHF/UHF TV bands
 - OFDM, SFN (Single Frequency Network)

Receiving environment for terrestrial TV broadcasting



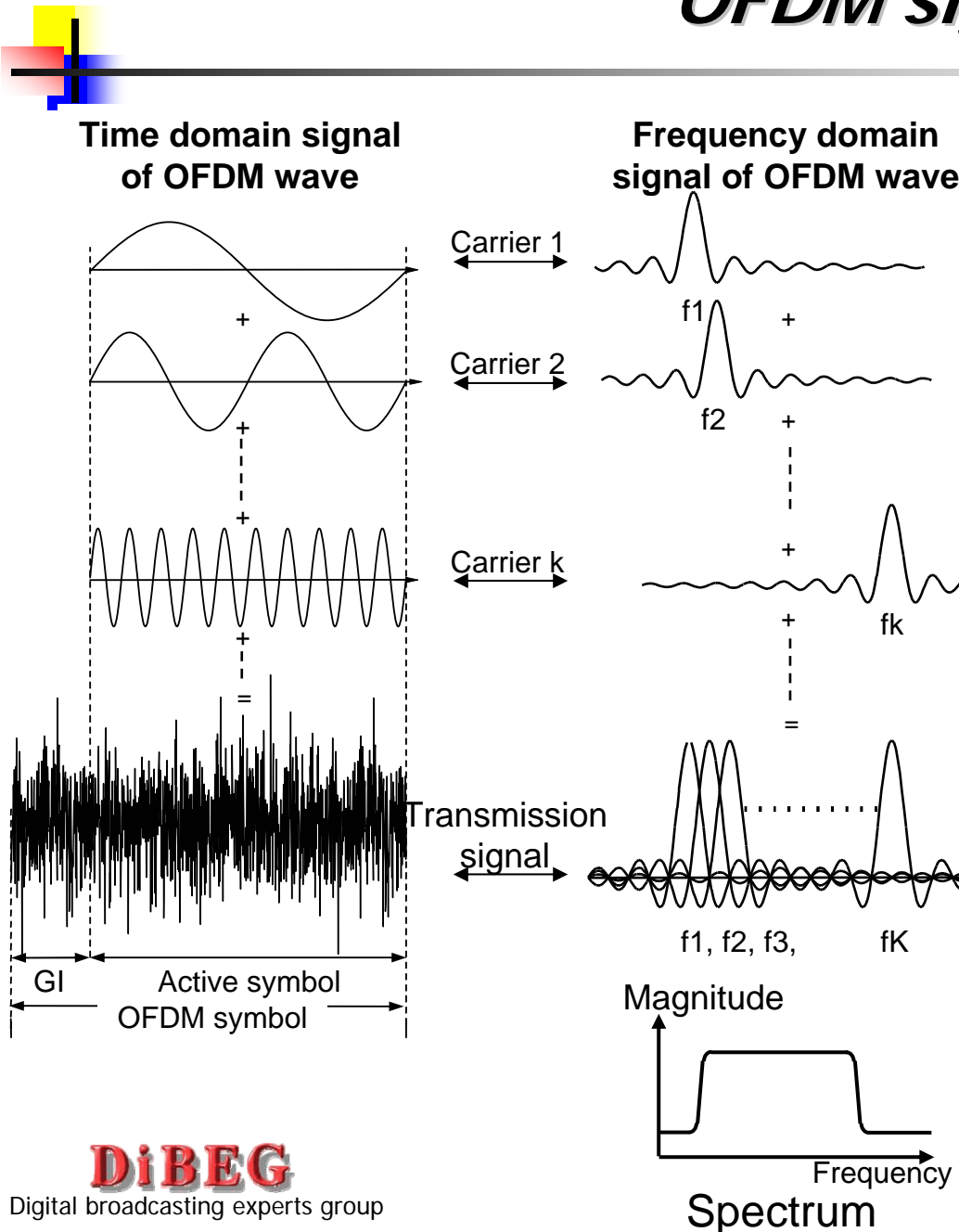
Key technologies for ISDB-T

Key technologies adopted in ISDB-T



- To overcome the terrestrial severe receiving environment
 - **OFDM**
 - **Time-interleaving** (*Freq.&Time interleave*)
- To realize the effective and smart transmission
 - **Hierarchical transmission** by segmented OFDM
 - Realization of One-Seg service for handheld reception

OFDM signal



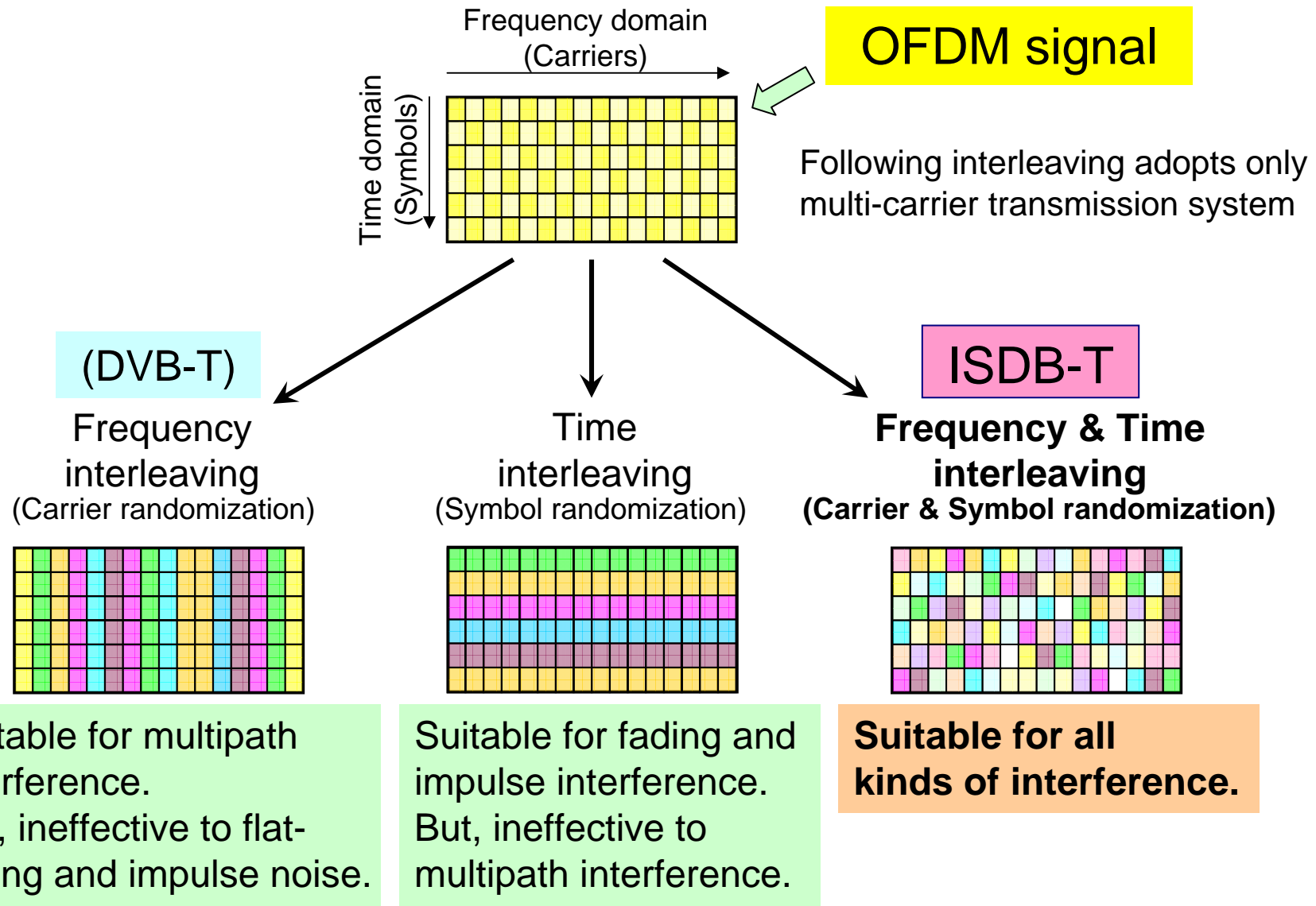
OFDM is

- Multi-carrier modulation
 - More than 2,000 carriers in a 6MHz TV channel
 - Long symbol duration compare to single-carrier transmission system
- Multipath proof modulation
 - by adding guard interval
- Modulation/demodulation can be processed by **IFFT/FFT.**

Features of OFDM signal

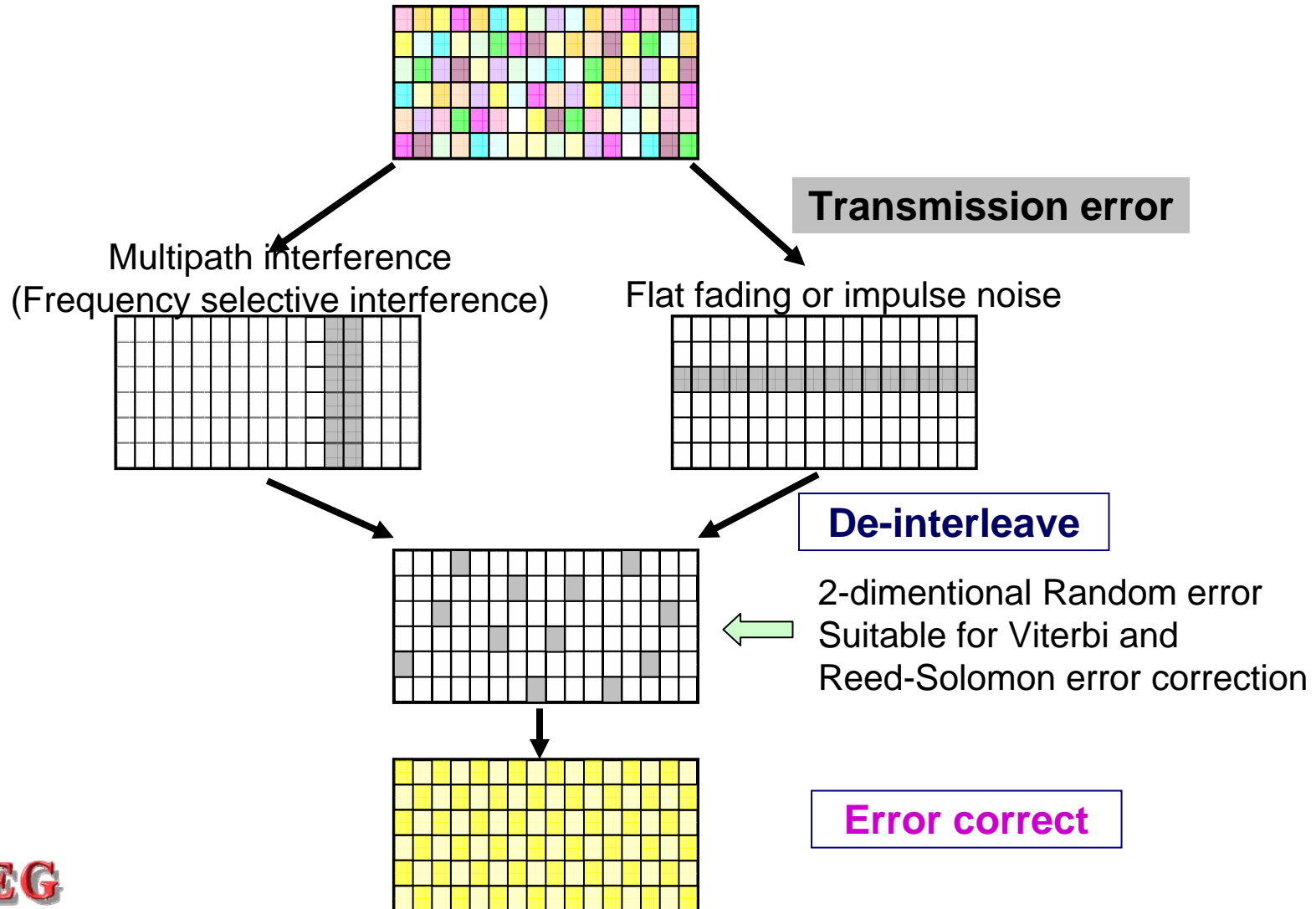
- Robustness against **multipath interference** and **frequency-selective fading**
 - OFDM uses many carriers, so symbol duration is longer than single carrier modulation.
 - Multipath interference cause rugged frequency shape. However frequency-selective interference is transformed to degradation of C/N, carrier by carrier.
 - Guard interval** mitigate the effect of multipath.
- **SFN** (Single Frequency Network)
 - Due to guard interval, SFN is possible.
 - Totally considering, OFDM is frequency effective modulation method by using SFN.

Frequency and time interleaving (1)



Frequency and time interleaving (2)

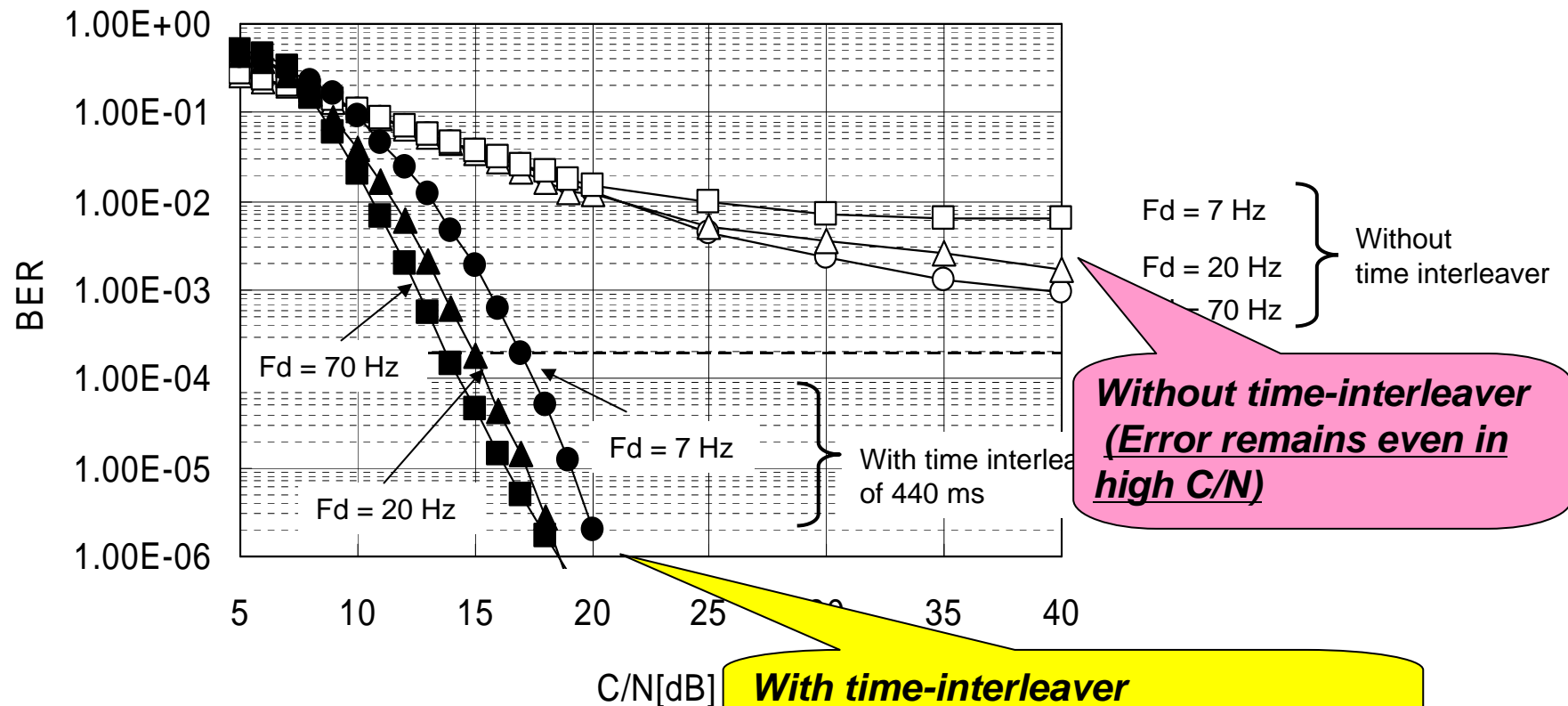
Frequency & Time interleaving (Carrier & Symbol randomization)



Effect of time interleaving

Laboratory test results

flat fading, DQPSK, Mode=1, GI=1/8, FEC=1/2, RS=OFF



**Without time-interleaver
(Error remains even in high C/N)**

**With time-interleaver
(No error at more than C/N=20dB)**

Hierarchical transmission

ISDB-T adopts hierarchical transmission system

- by **FDM (frequency division multiplexing) of Segment**

Hierarchical transmission is realized by changing following parameters

- **Modulation** : QPSK, 16QAM, 64QAM, (DQPSK)

QPSK	16QAM	64QAM
<p>← More robust</p> <p>Higher capacity →</p>		

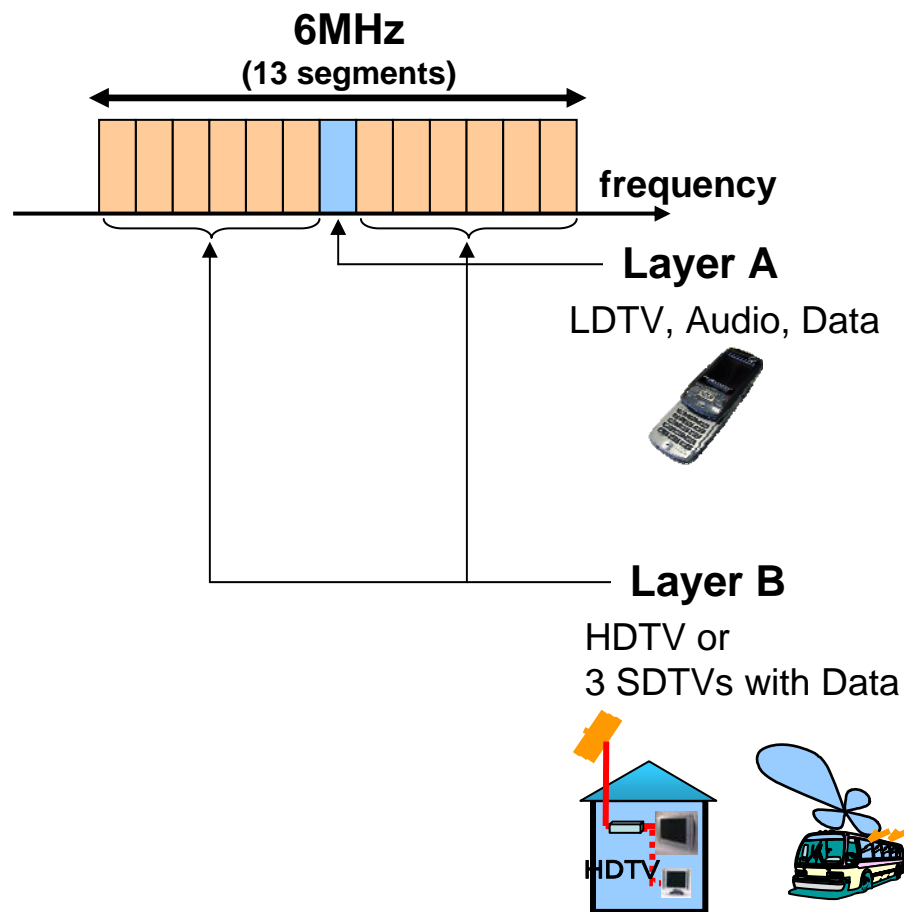
- **Error correction** : Coding rate of convolutional code (1/2 - 7/8)

1/2	2/3	3/4	5/6	7/8
<p>← More robust</p> <p>Higher capacity →</p>				

Example of hierarchical transmission

Example

(2 layers transmission)



Layer A
Handheld reception
(One-Seg service)

QPSK
FEC=2/3

For handheld service

Robust transmission mode

Layer B
Fixed reception, Mobile reception (HDTV, etc)

64QAM
FEC=3/4

For HDTV service

High capacity transmission mode



Features of ISDB-T transmission system

1. Robustness against interference

- (1) Adopt OFDM transmission system
- (2) Adopt time interleaving; very effective for various kinds of interference
- (3) Adopt concatenated error correction with plural interleaver

2. Fixed and mobile (handheld) service can be realized in one transmission channel

- (1) Hierarchical transmission by segmented OFDM
- (2) Partial reception of center one-segment for handheld service

3. Efficient frequency utilization

- (1) Adopt OFDM transmission system; SFN operation
- (2) Adopt hierarchical transmission; service for different type of reception in one frequency channel

4. Flexibility for several type of service/reception style

Transmission parameters of ISDB-T (6MHz Bandwidth)



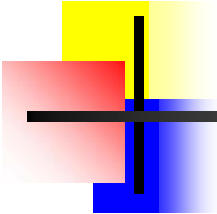
ISDB-T mode	Mode 1 (2k)	Mode 2 (4k)	Mode 3 (8k)
Number of OFDM segment	13		
Useful bandwidth	5.575MHz	5.573MHz	5.572MHz
Carrier spacing	3.968kHz	1.984kHz	0.992kHz
Total carriers	1405	2809	5617
Modulation	QPSK , 16QAM , 64QAM , DQPSK		
Number of symbols / frame	204		
Active symbol duration	252 μ s	504 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		

ARIB standards and ITU-R recommendations for ISDB-T



Items	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
Receiver	ISDB-T receiver	STD-B21	—
Operational guideline	ISDB-T broadcasting operation	TR-B14	—

3. Comparison of 3 DTTB systems

- 
- A decorative graphic on the left side of the slide, featuring a yellow square at the top, a red square to the left, and a blue square at the bottom, with a black crosshair overlaid.
-
- Comparison of 3 DTTB systems
 - Results of comparison test in Brazil
 - Summary of comparison

Technical features of DTTV Systems

System		ATSC	DVB-T	ISDB-T
Modulation		8VSB	OFDM (QPSK, 16QAM,64QAM)	Segmented OFDM (DQPSK,QPSK, 16QAM,64QAM)
Inter-leaving	Bit/Symbol	Yes	Yes	Yes
	Frequency	-	Yes	Yes
	time	-	-	0s, 0.1s,0.2s,0.4s
Excess Bandwidth/ Guard Interval		11.5%	1/4,1/8,1/16,1/32	1/4, 1/8,1/16,1/32
Configuration		-	TPS	TMCC
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

Results of Brazilian Tests

- **Comparison tests for three DTTB systems**
 - ATSC, DVB-T, ISDB-T
- **Carried out from Aug. 1999 to April 2000**
- **Laboratories tests**
 - AWGN, impulse noise, multipath, Doppler effect
- **Field tests**
 - Coverage, gap-filler, indoor reception, etc.

ISDB-T shows superior performances especially for following items

- (1) Robustness against impulse noise (urban noise)
- (2) Coverage; robustness of ISDB-T system leads wide cover area
- (3) Indoor reception; Robustness against impulse noise and fading leads good performance of indoor reception

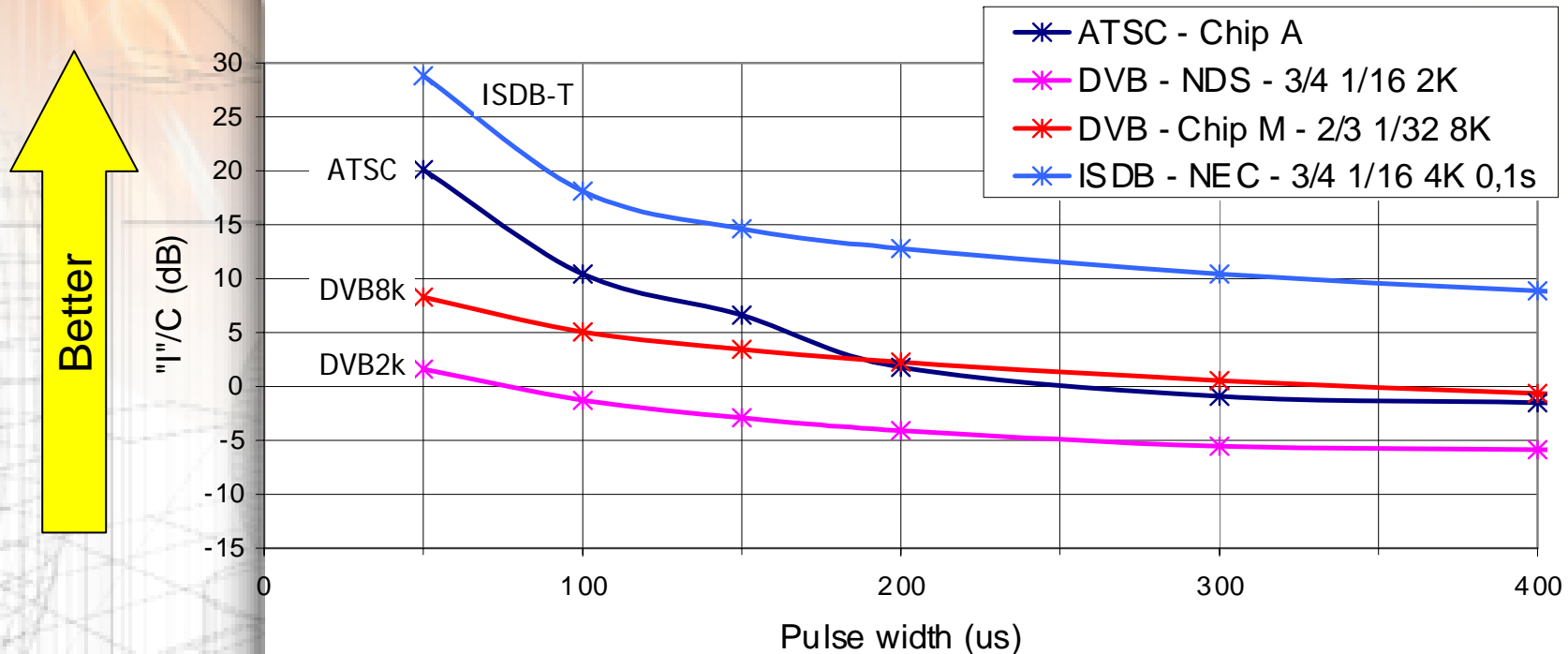
Selected transmission parameters

- Transmission parameter : almost same bit rate
- **ATSC**
 - Fixed, 8VSB FEC=2/3 (19,39 Mbit/s)
- **DVB-T**
 - **DVB-2K** : 64QAM FEC=3/4 GI=1/16 2K (19,75 Mbit/s)
 - **DVB-8K** : 64QAM FEC=2/3 GI=1/32 8K (18,09 Mbit/s)
- **ISDB-T**
 - ISDB-4k : 64QAM FEC=3/4 GI=1/16 4K 0,1s (19,33 Mbit/s)
- Reference BER
 - After RS decoding : 3×10^{-6}

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

Impulse Noise

Relation between the noise pulse width & interference to signal ratio

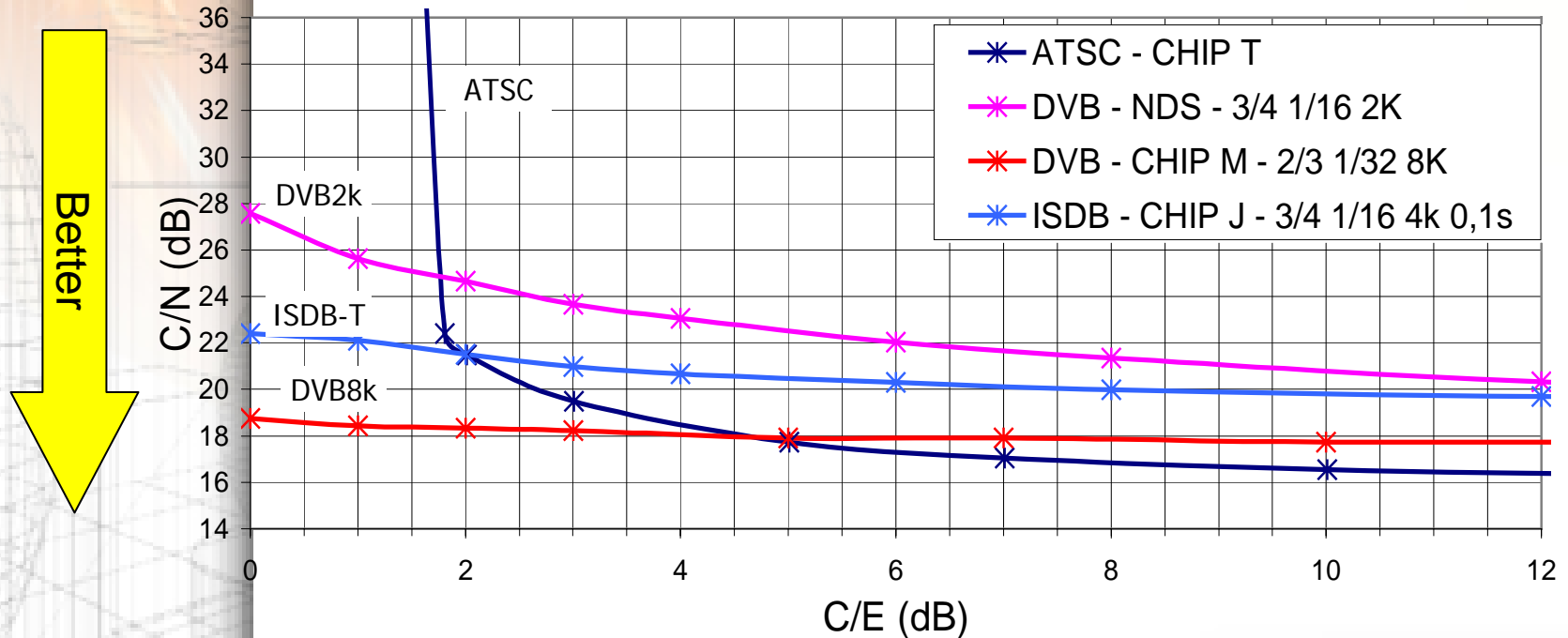


- Better performance of the ISDB-T system, by introducing time interleaving

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

Static Multipath

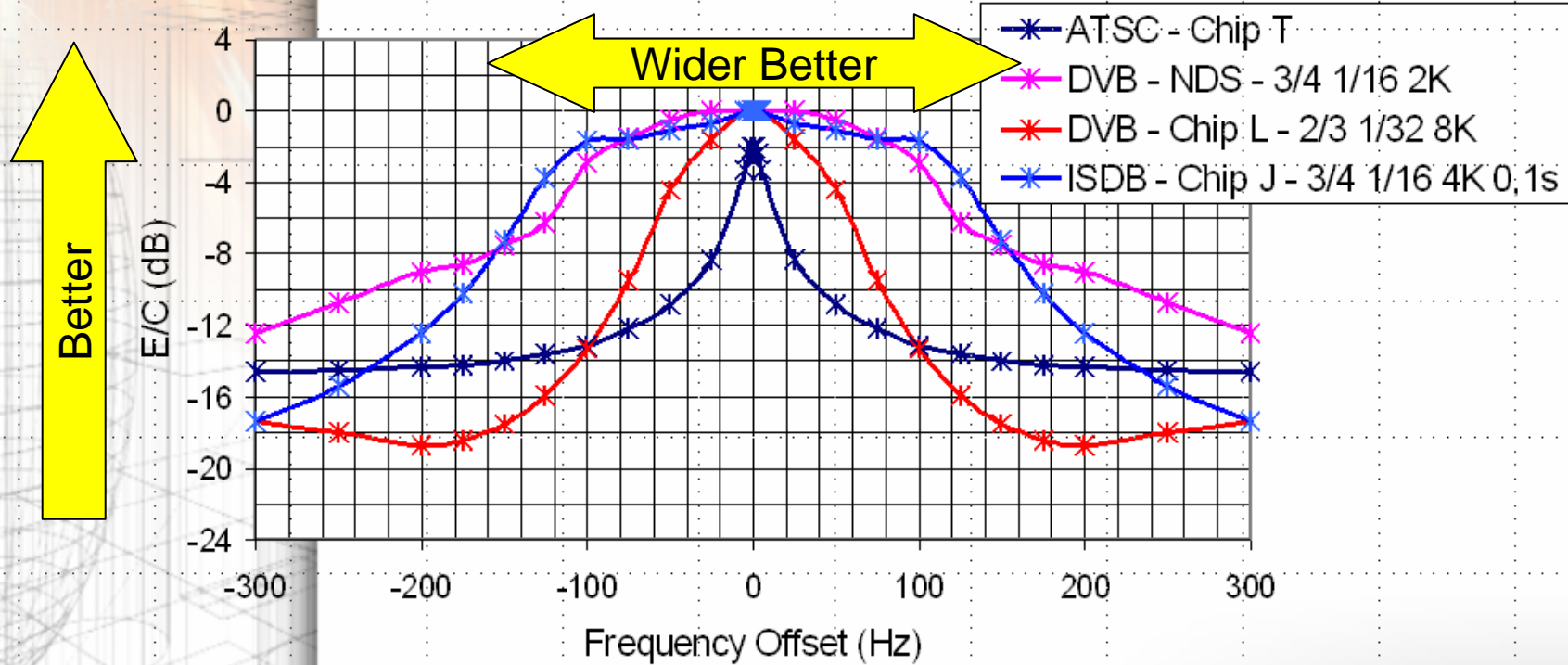
Carrier to noise ratio as a function of carrier to echo ratio
Comparison at post-echo = 8us



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

Doppler Effect

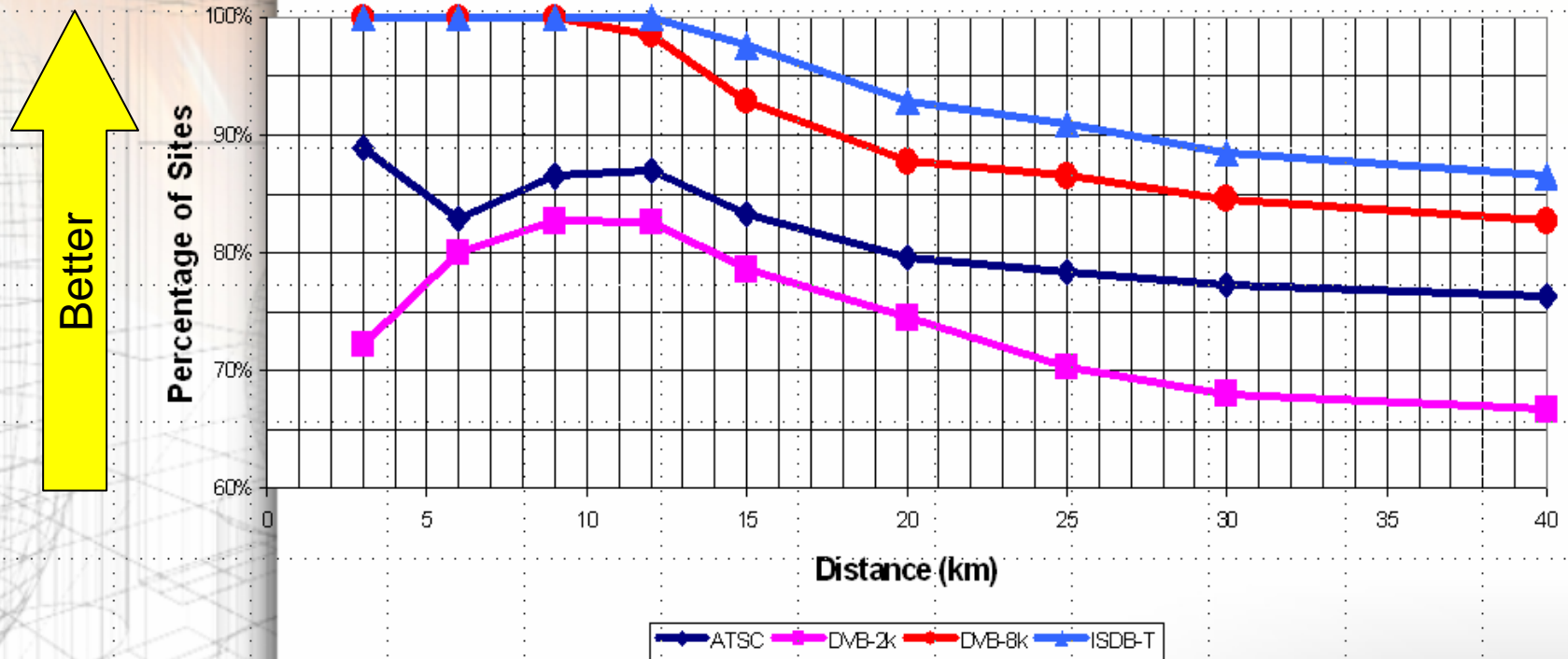
Echo to carrier ratio as a function of frequency offset
Comparison at post-echo = 8 us



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

Outdoor: Coverage

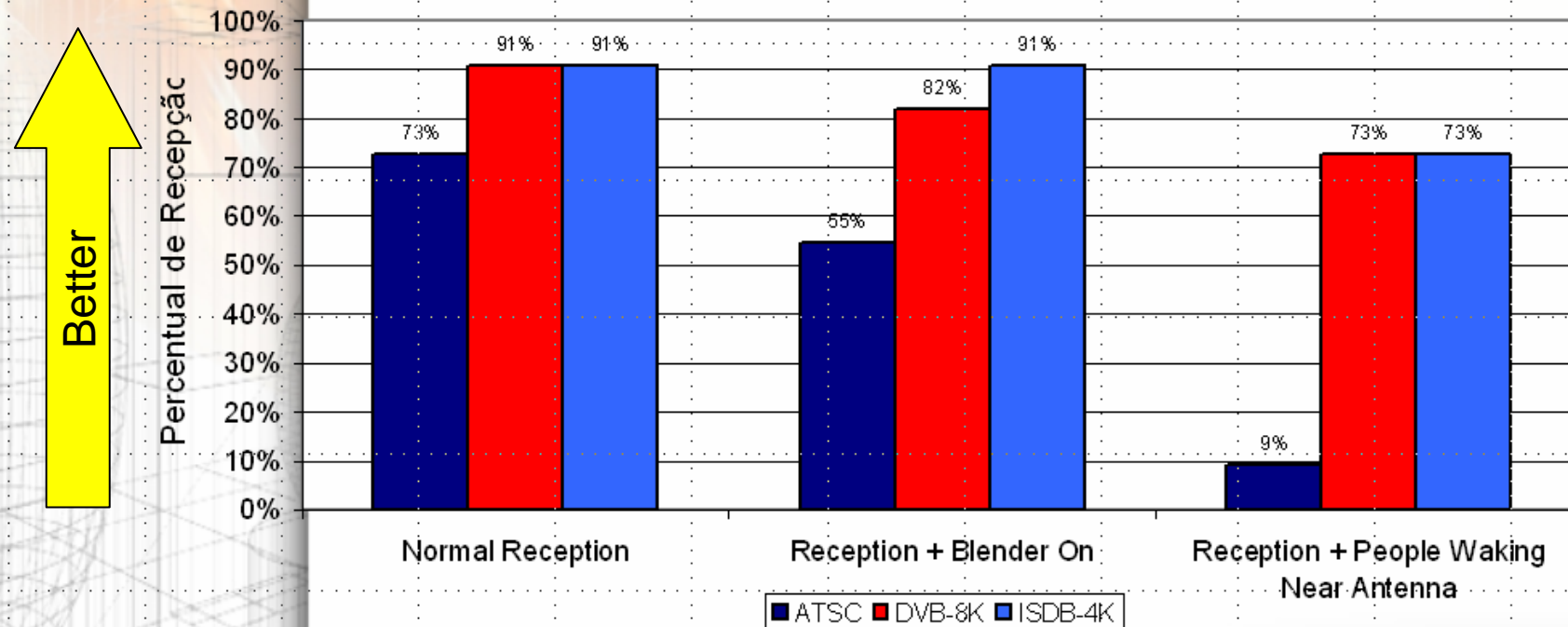
Success on Receiving - Cumulative Function
Criterion: Number of Errors < 5



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

Indoor Reception

Indoor Reception: Sites Where the Three Systems Were Tested in the Same Condition



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

Essence of comparison test results

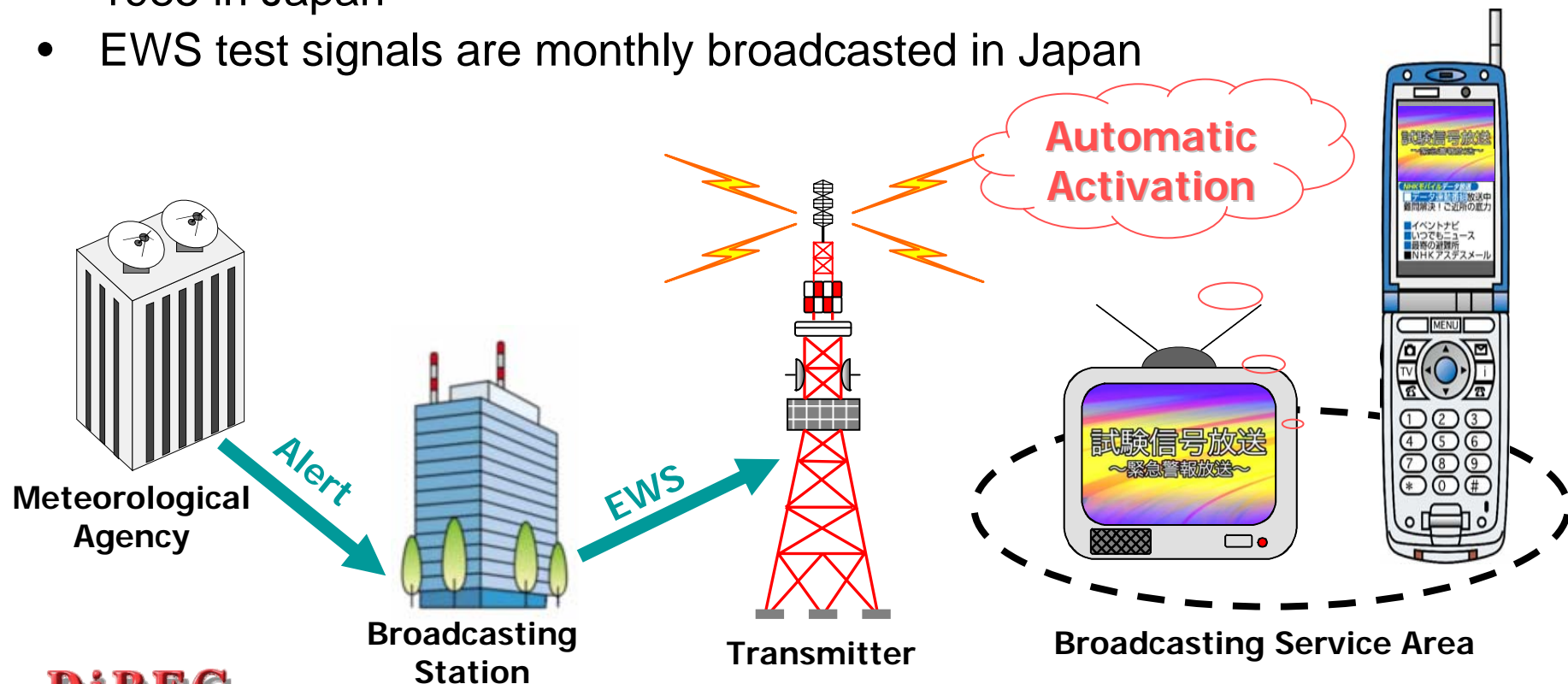
- The **OFDM** modulation scheme is suitable for DTTB in real broadcast circumstances.
- **Time interleaving** scheme, adopted in ISDB-T, is a key technology for mobile digital transmission and is also effective to cope with impulse noise degradation.
- **ISDB-T showed the best results** in Brazil's comparison tests.

4. Emergency Warning System

- EWS for broadcasting
- Service image of EWS
- EWS for One-Seg
- Key technology for power saving

Emergency Warning System for broadcasting

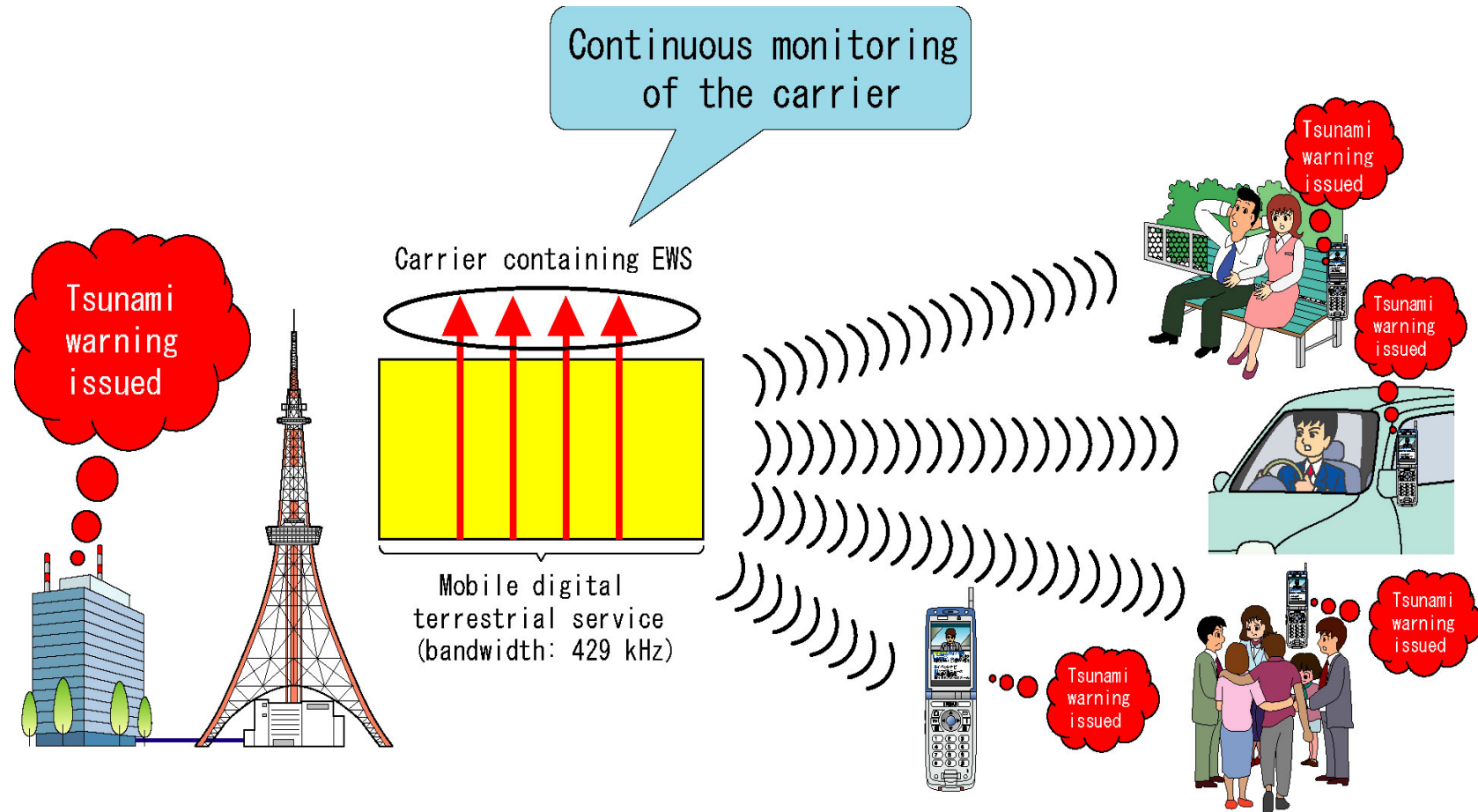
- Remote activation of Radio & TV ready for EWS
 - AM, FM Radio & TV : Control signal and Alert Sound
 - Digital Broadcasting (ISDB-T) : Emergency Warning Control Flag
- EWS for analog broadcasting has been operated since September 1985 in Japan
- EWS test signals are monthly broadcasted in Japan



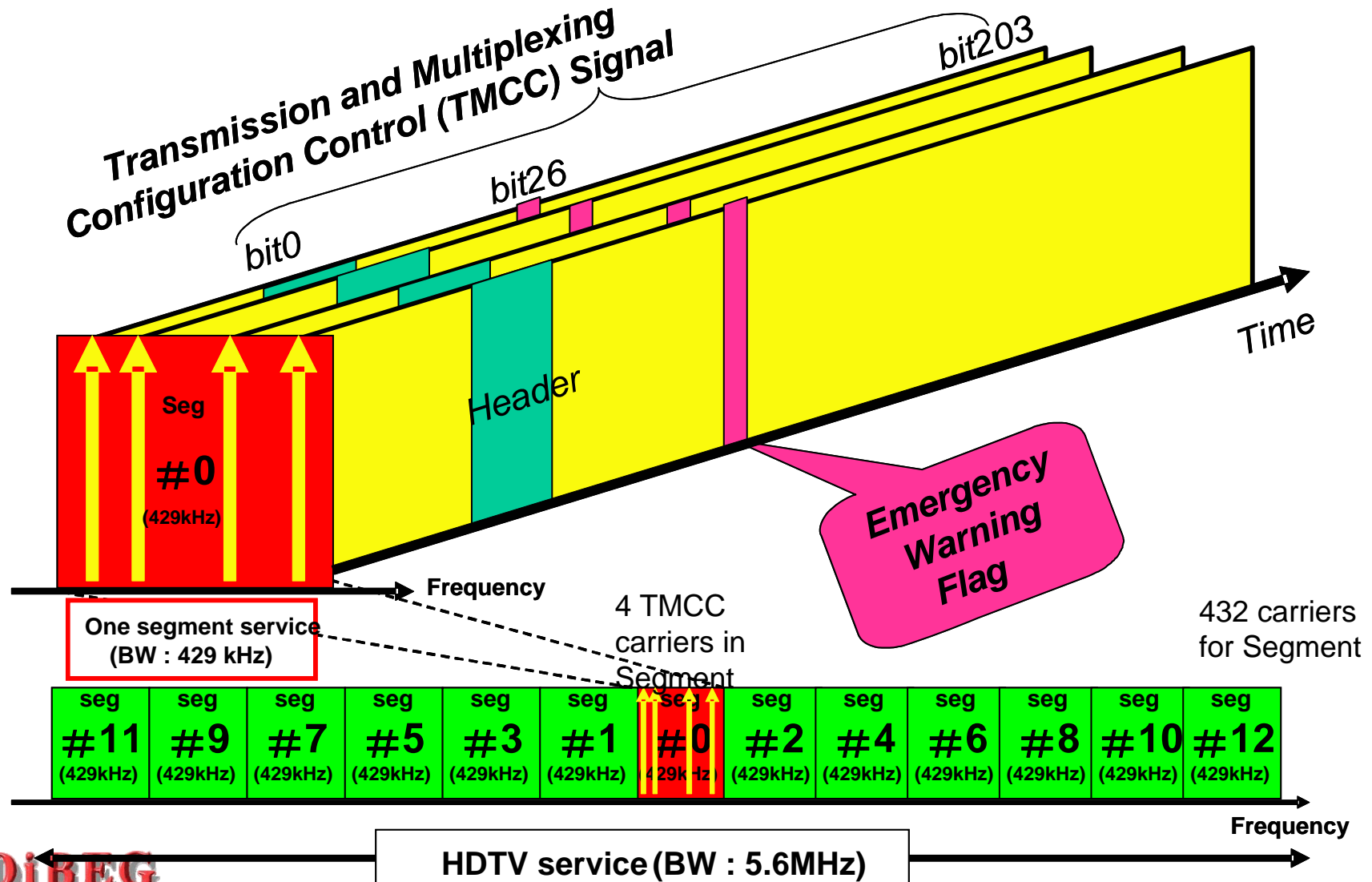
Functions of broadcasting in disaster management

1. Gathering/receiving disaster information from administrative organizations
 2. Filtering information (important or not)
 3. Delivering disaster information to the general public
 4. Broadcasting offers reliable information
There is no “spam” information in broadcasting
 5. Broadcasting is always connected to everybody
There are no congestions like in communication
 6. Broadcasting is always active : 24 hour operation
- **Broadcasting is an ideal media to deliver disaster information to the general public**

Concurrent mobile receiver activation using EWS



EWS signal allocation in ISDB-T



EWS for ISDB-T One-Seg services

- EWS for ISDB systems have already been in operation in Japan as well as analog broadcasting
- Portable EWS receivers for One-Seg are now under development
- One-Seg receivers are expected to enlarge the opportunity to avoid disaster
- Key technology is power consumption saving in stand-by mode



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.



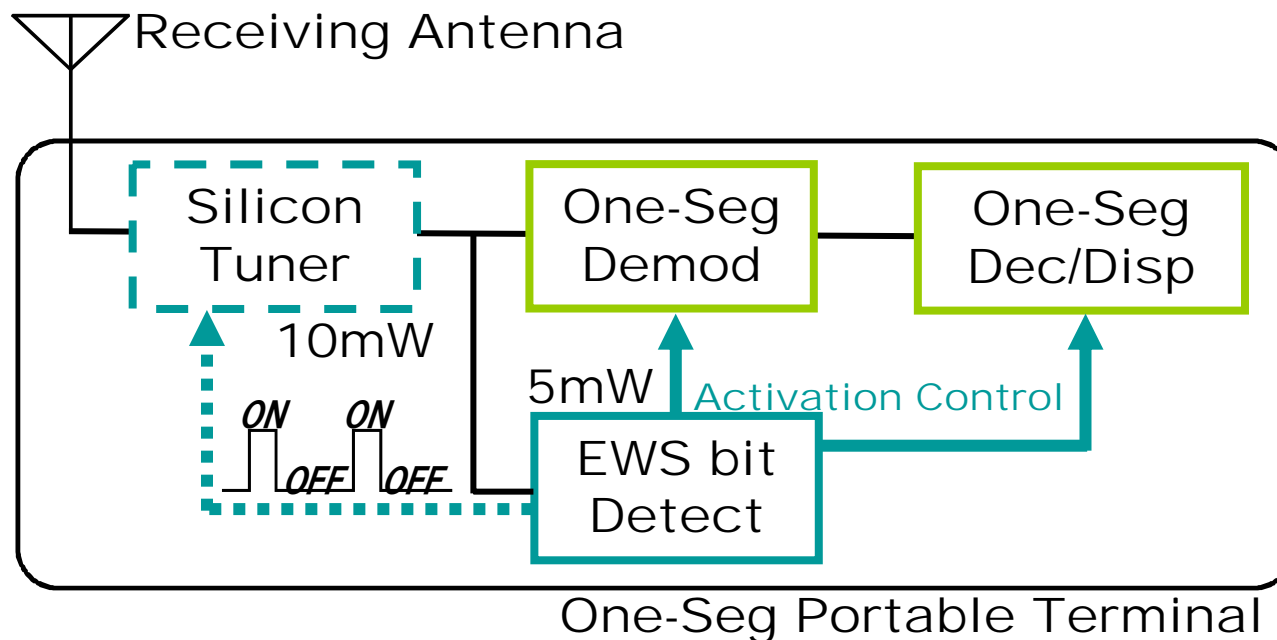
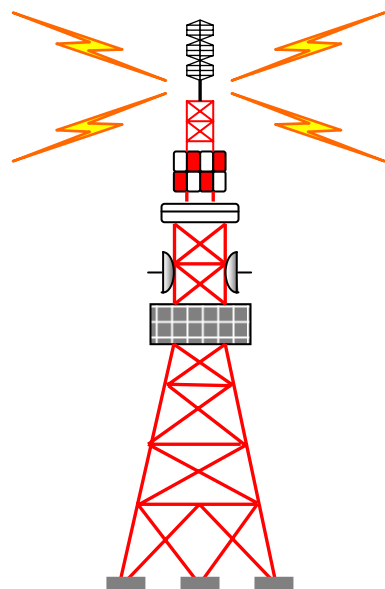
The problem is power consumption
of mobile terminals



Power consumption saving is required
during EWS stand-by mode

We developed the key technology

Key technology for power saving while EWS stand-by mode



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

More than 10 times improved

DiBEG

Digital broadcasting experts group

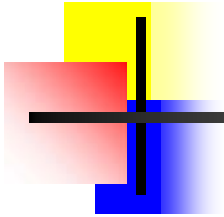
5. Conclusions



Conclusions

- **ISDB-T** is the *most robust* transmission system
 - Adopting OFDM and time-interleaving
 - Brazilian comparison tests prove it
- **HDTV** (or **SDTV multi-channel**) and **One-Seg** (handheld TV service) can be transmitted *simultaneously* in a channel
 - *ISDB-T enables both digital TV service for fixed and mobile (handheld) by just one transmission facility*
- **SFN** is possible for effective frequency utilization
- Key technology for power saving of **One-Seg EWS** stand-by mode has been almost completed

Thank You for Your Attention!



Digital Broadcasting Expert Group

<http://www.dibeg.org/>
mail; info@dibeg.org

DiBEG

Digital broadcasting experts group