

ISDB-T seminar in Brazil

Seminar #4

Transmission system (part 1)

30th March, 2005

Digital Broadcasting Expert Group (DiBEG)

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In this section, mainly the principle of channel coding and OFDM Modulation technology are presented
The transmission characteristics will be presented in next section.

Contents

1. Outline of ISDB-T transmission system
 - 1.1 Features of ISDB-T and technical baseline
 - 1.2 Block diagrams of transmission system
 - 1.3 transmission parameter
2. Principle of segment construction and hierarchical transmission
3. Transmission coding
 - 3.1 Channel coding
 - 3.2 Mapping and Interleaving
4. OFDM modulation
 - 4.1 OFDM modulation and Guard interval adding
 - 4.2 Quadrature modulation
5. Outline of ISDB-T_{SB}
 - 5.1 outline of ISDB-T_{SB} transmission system
 - 5.2 Consecutive transmission system
 - 5.3 example of consecutive transmission station

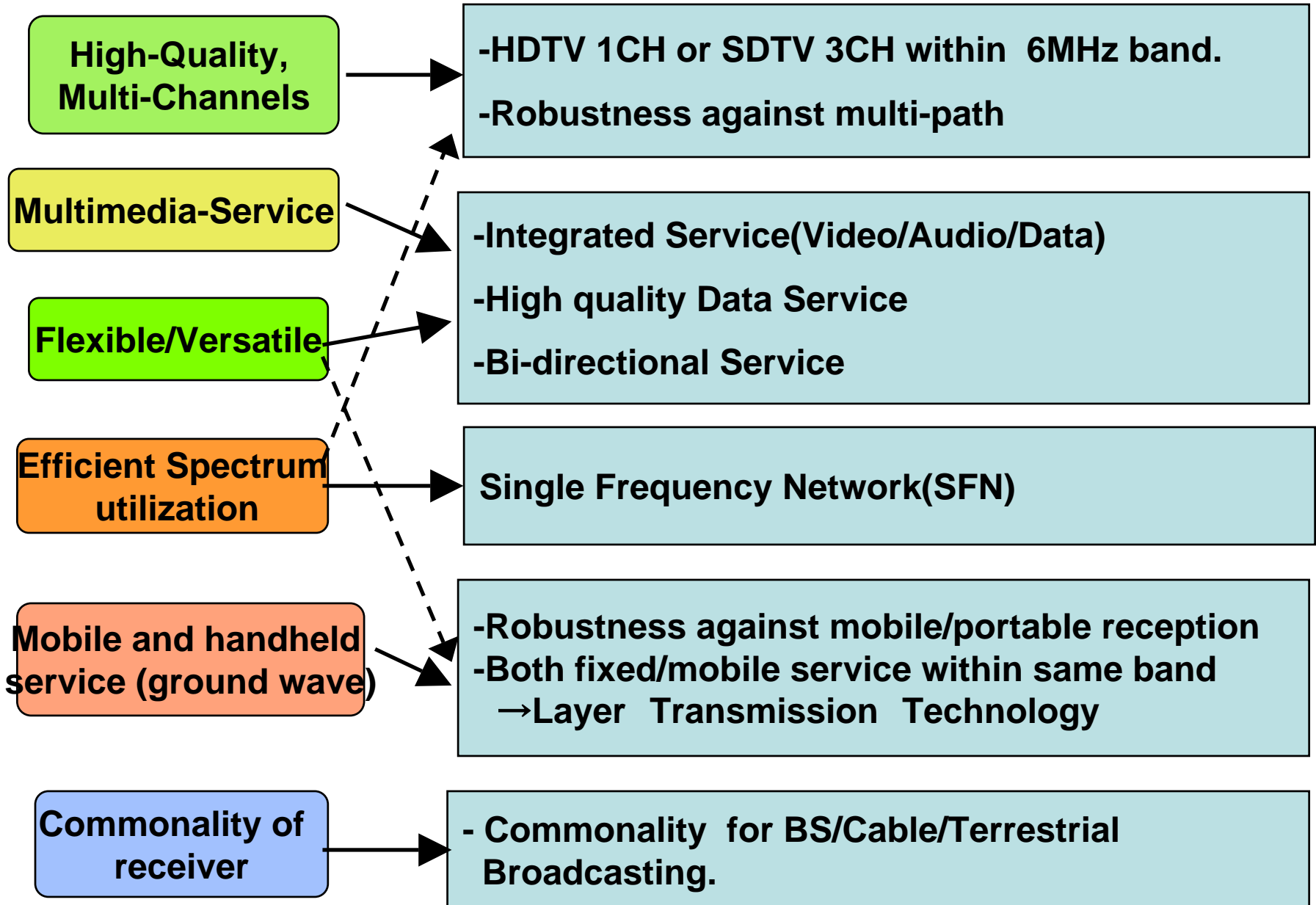
1. Outline of ISDB-T transmission system

1.1 Features of ISDB-T and technical baseline

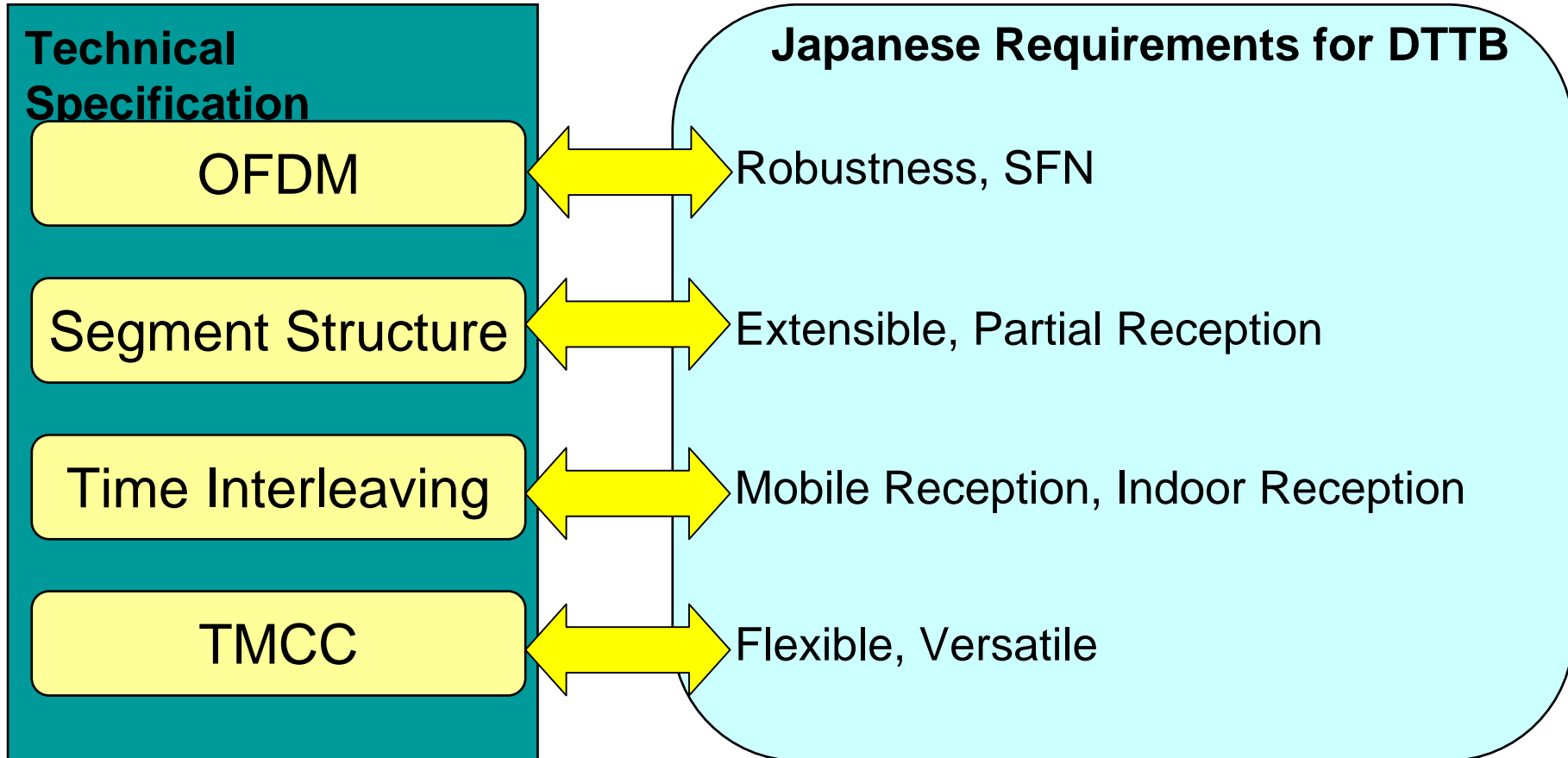
1.2 Block diagrams of transmission system

1.3 transmission parameter

Requirement for Digitization → Solutions

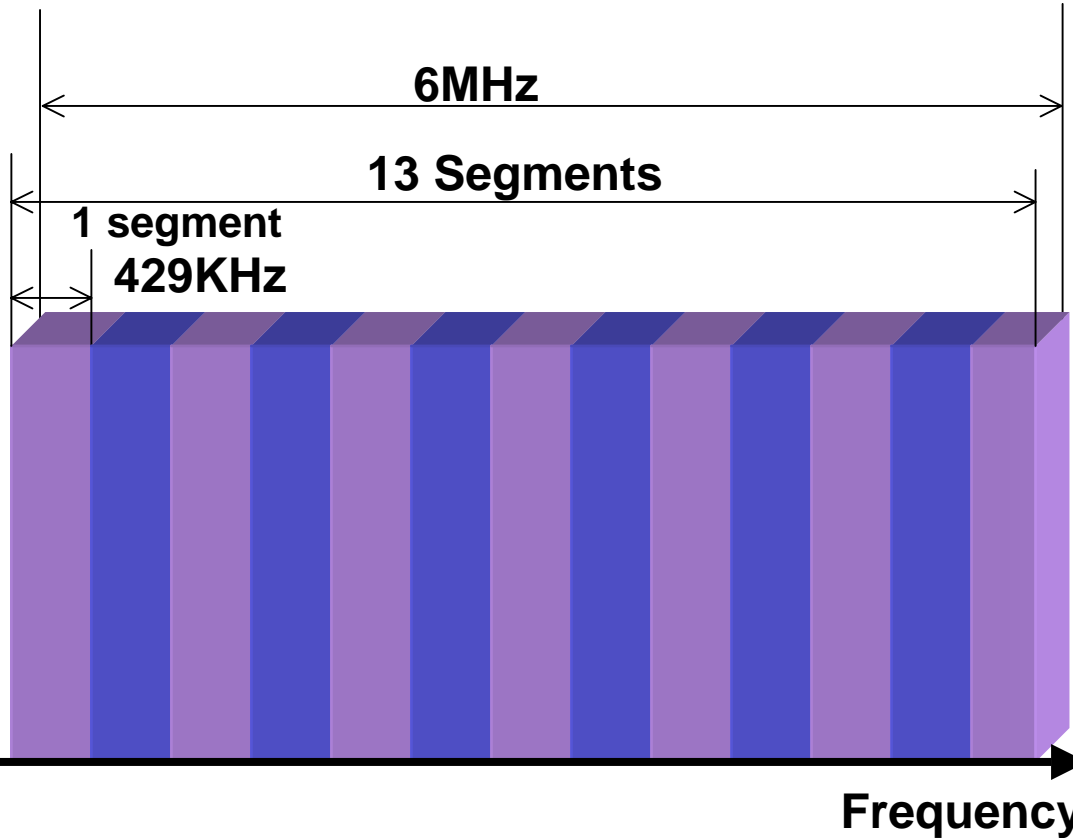


Features of ISDB-T



ISDB-T system

Band Segmented OFDM : Orthogonal Frequency Division Multiplexing



Features

- Modulation: DQPSK, QPSK, 16QAM, 64QAM
- 1HDTV or 3 SDTV/channel
- Net data rate: 23.42Mbps (6MHz)
- Single Frequency Network
- Mobile reception (time interleaving)

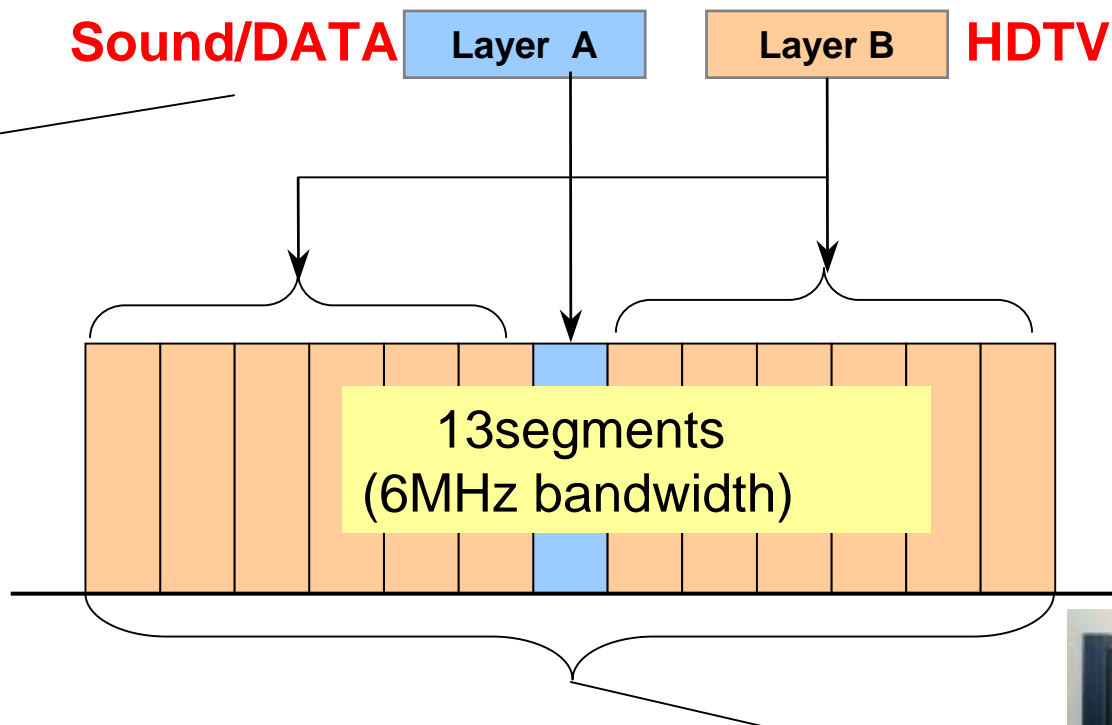
Segmented Structure and Partial Reception

HDTV + mobile reception within one 6MHz channel

Sound/DATA Layer A Layer B HDTV (or 3 SDTV)



Mobile reception



HDTV reception

Feature of ISDB-T transmission system

1. Efficient frequency utilization

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

2. Mobile/ handheld service in one transmission standard

- (1) Time interleave; Improve mobile reception quality
- (2) Partial reception; handheld service in same channel

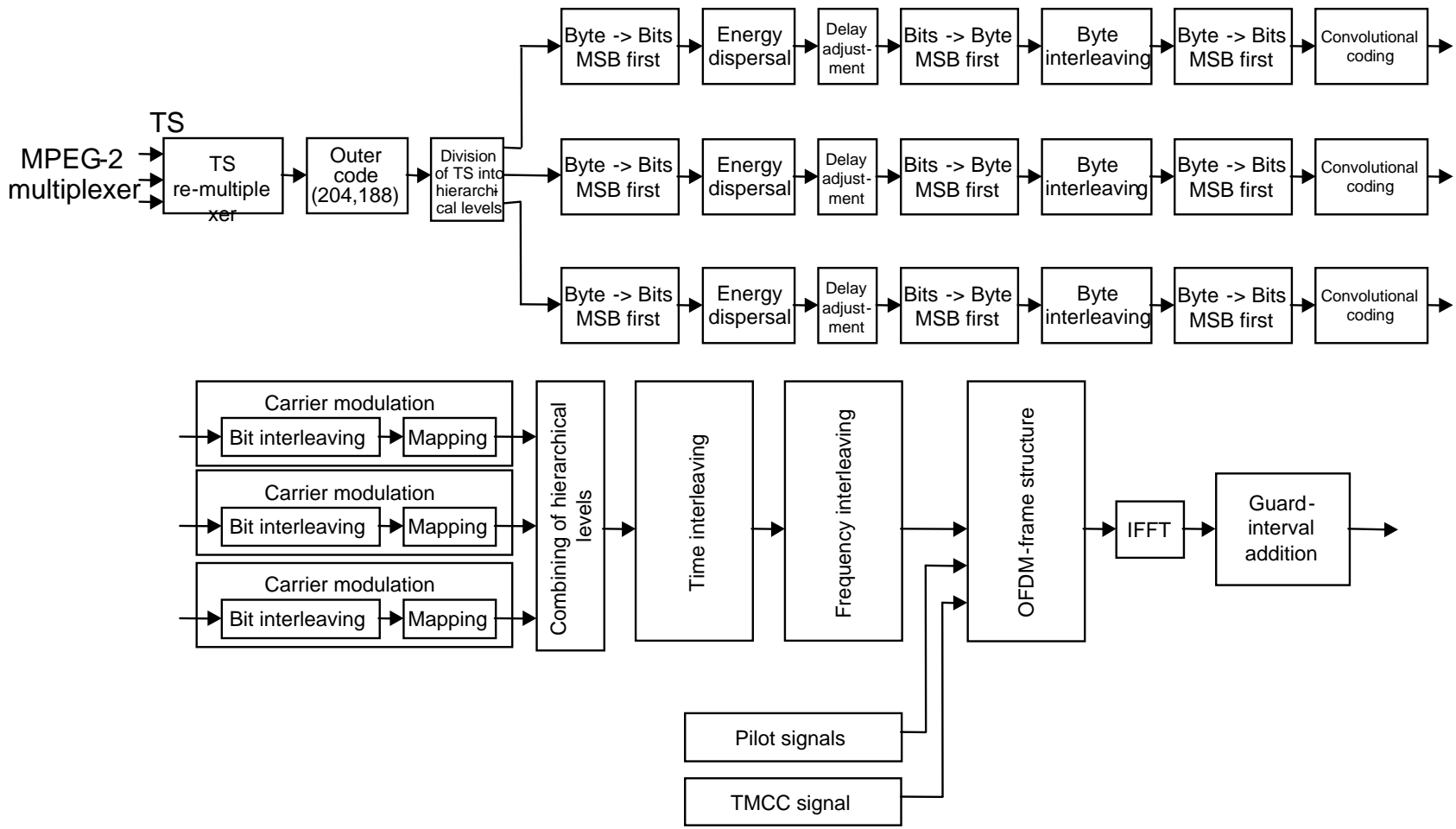
3. Robustness against interference

- (1) Adopt concatenated error correction with plural interleave
- (2) Time interleave; very effective for impulse noise (urban noise)

4. Flexibility for several type of service/ reception style

5. Commonality of TV/audio transmission standard

6. Auxiliary (AC) channel can be used for transmission network management



Transmission system blockdiagram(B31 Fig.3-2)

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	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		

2. Segment construction and Hierarchical Transmission

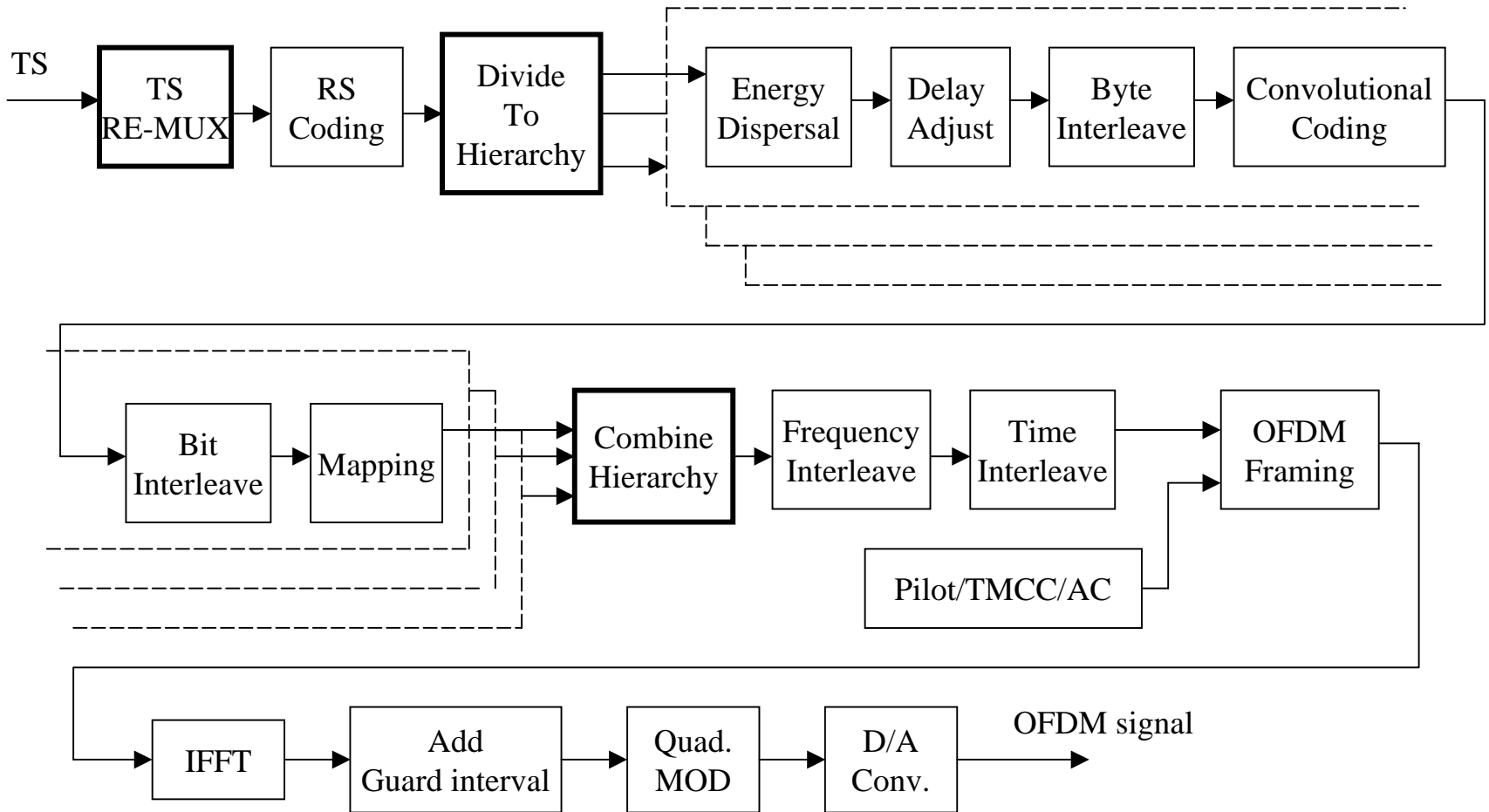
2.1 Concept and feature of hierarchical transmission system

2.2 The rules of hierarchical transmission

2.3 Segment construction and hierarchical transmission

Relating clause of ARIB standard; B31 clause 3.2

Blockdiagram of ISDB-T Transmission coding



These functions are presented in this section

2.1 Concept and feature of hierarchical transmission system

Hierarchical transmission is the feature of ISDB-T, this concept is not in DVB-T system. The concept of hierarchical transmission system is shown in figure.2-1 after.

The transmission parameters can be assigned as each service ID. This transmission system is called “**hierarchical transmission**”

For example, the service which should be strong against interference such as noise should be assigned to QPSK layer, other service is assigned to 64QAM layer.

In this case, service of QPSK layer could be received under serious receiving condition such as handheld reception.

In case of DVB-T system, for handheld reception service, another frequency should be prepared separately. But, in ISDB-T system, different reception service can be achieved within one frequency channel by making use of this transmission system.,

TSP's are divided into plural layers at Re-multiplexer, and re-arranged in each layer. After re-arranged, these TSP's are combined to 1 transport stream and feed to OFDM modulator. (see figure. 2-2)

Fig.2-1 Image of hierarchical transmission

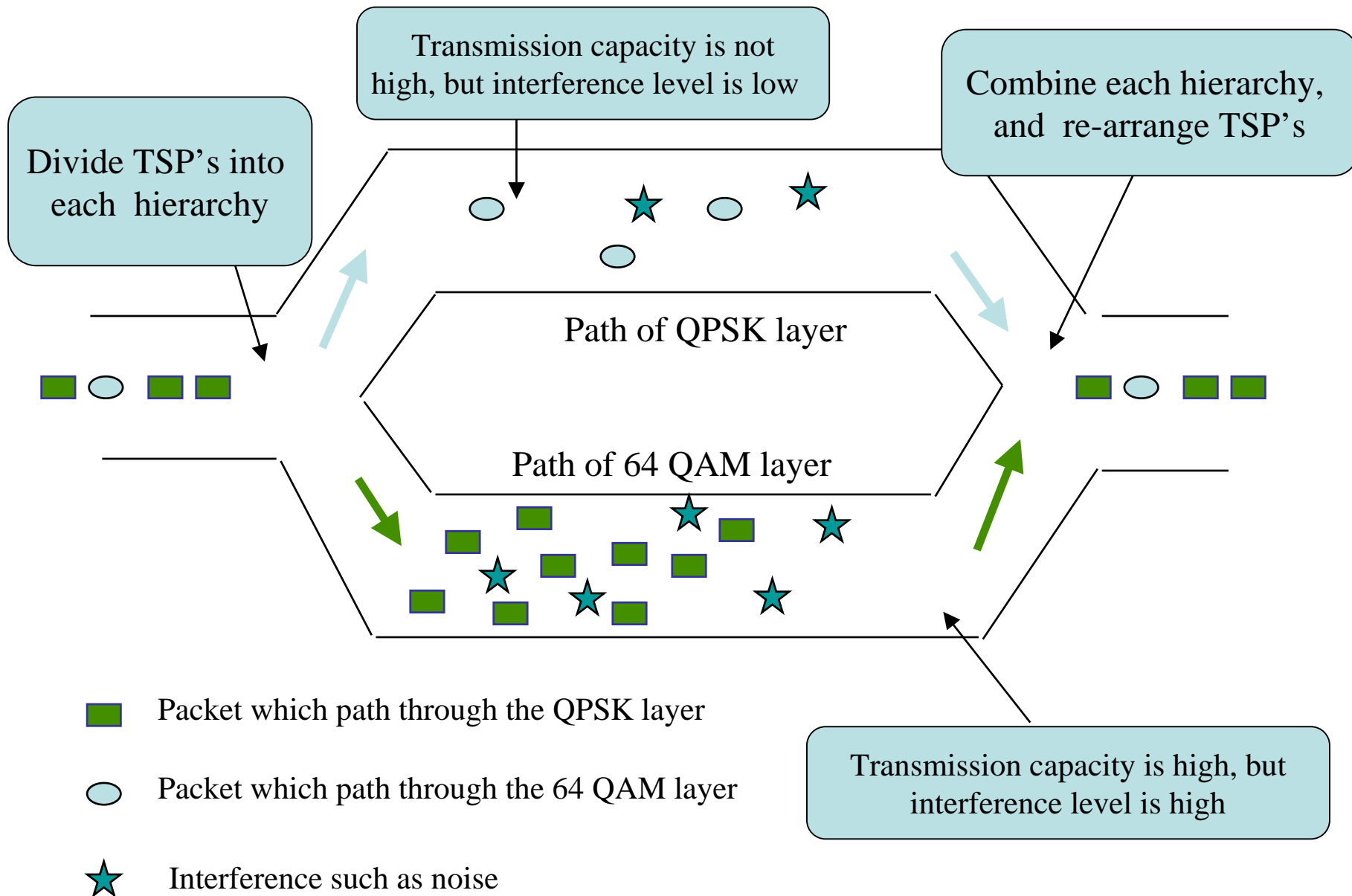


Fig. 2-2 Blockdiagram of TS re-multiplexer

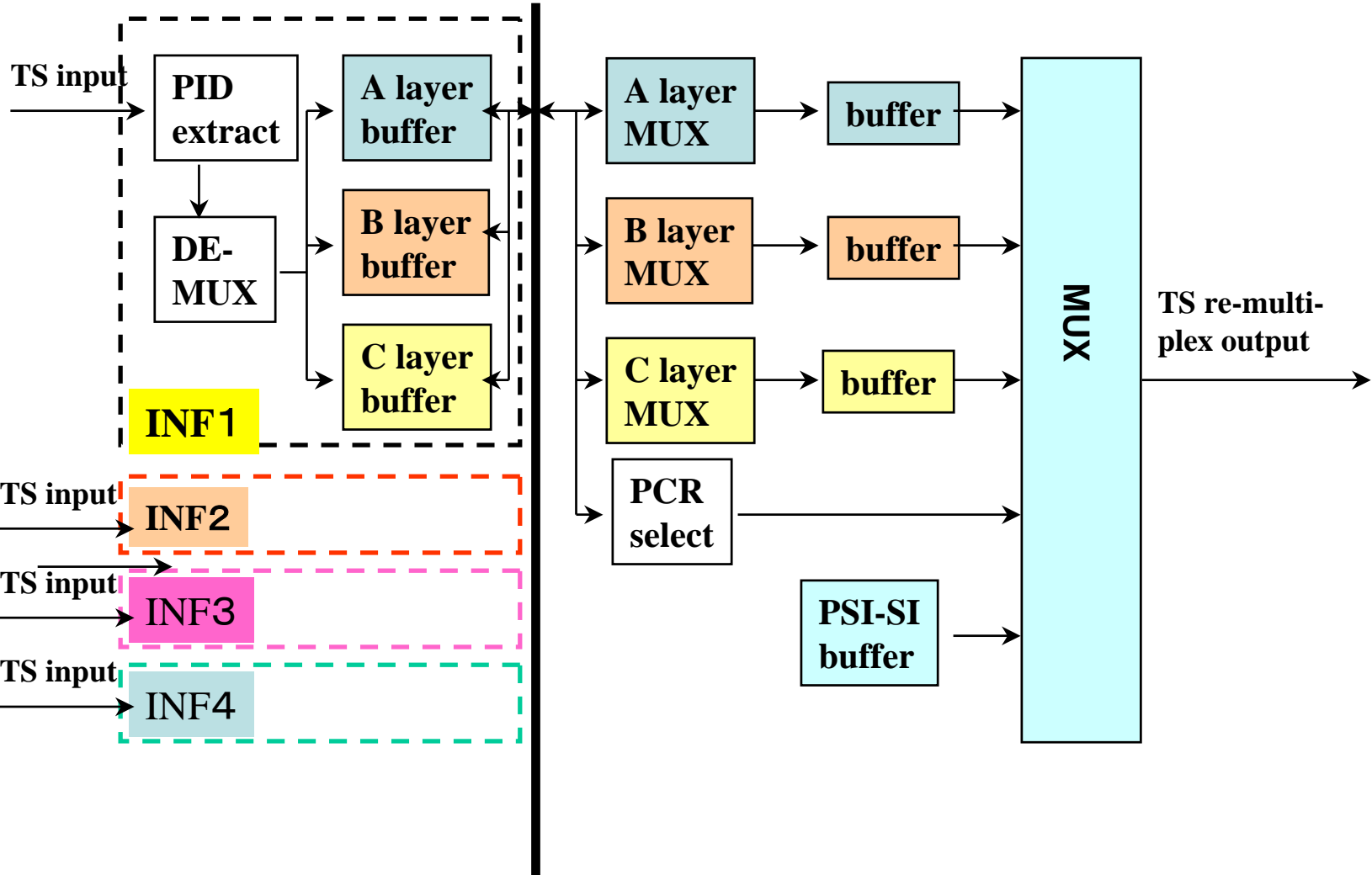
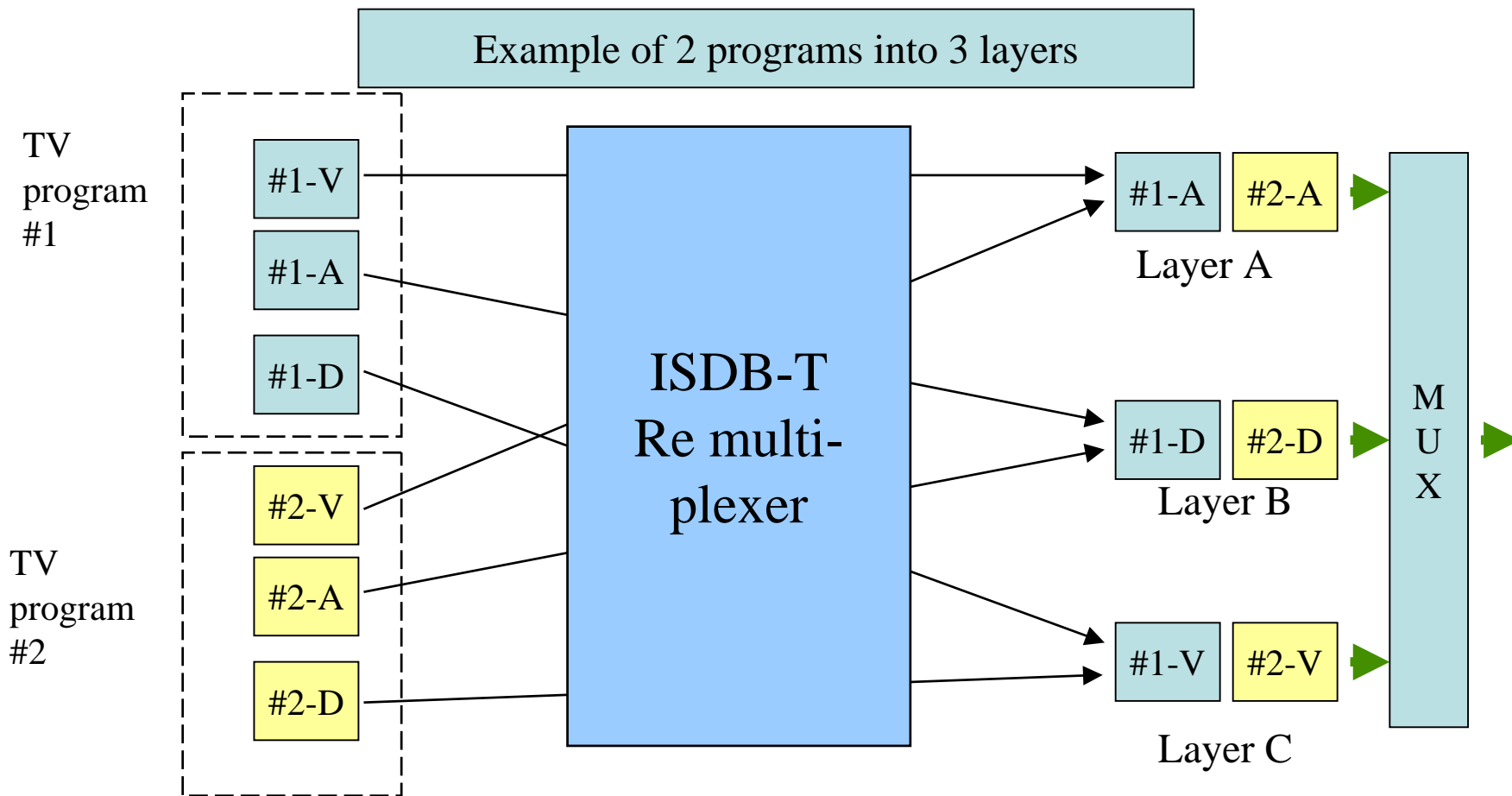


Fig. 2-3 Image of multiple layer transmission



2.2 The rules of hierarchical transmission

(a) The strongest hierarchy layer should be able to be demodulated and decoded alone .

Reason; to be able to demodulate and decode, PCR and minimum required PSI should be transmitted by strongest layer. (see Fig.2-4)

(b) Transmission delay difference between hierarchy should be compensated at the transmission side. The compensated transport stream is called “Multi-frame pattern” Image of Multi-frame pattern is shown in Fig. 2-5 later

(c) Multi-frame pattern should be completed within 1 OFDM frame.

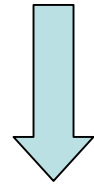
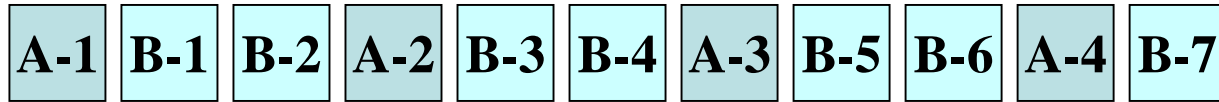
(d) The number of packet in 1 segment should be integer in any combination of transmission parameter and coding rate.

Reason; minimum unit of hierarchical transmission is the segment.

(e) Even though the information transmission speed is different because of its transmission parameters, the clock rate of TS at the output of receiver RS decoder should be constant(for TV, clock rate is 4fs). To adjust the clock rate, Null packets are inserted. See details in fig. 2-6 later.

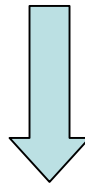
Fig. 2-4 Concept of hierarchical transmission
(strongest layer should be recovered alone)

Transmit
TSP (RS
input)



The B layer packets are
interfered and broken

Received TSP
(RS output)



Recovered TSP's

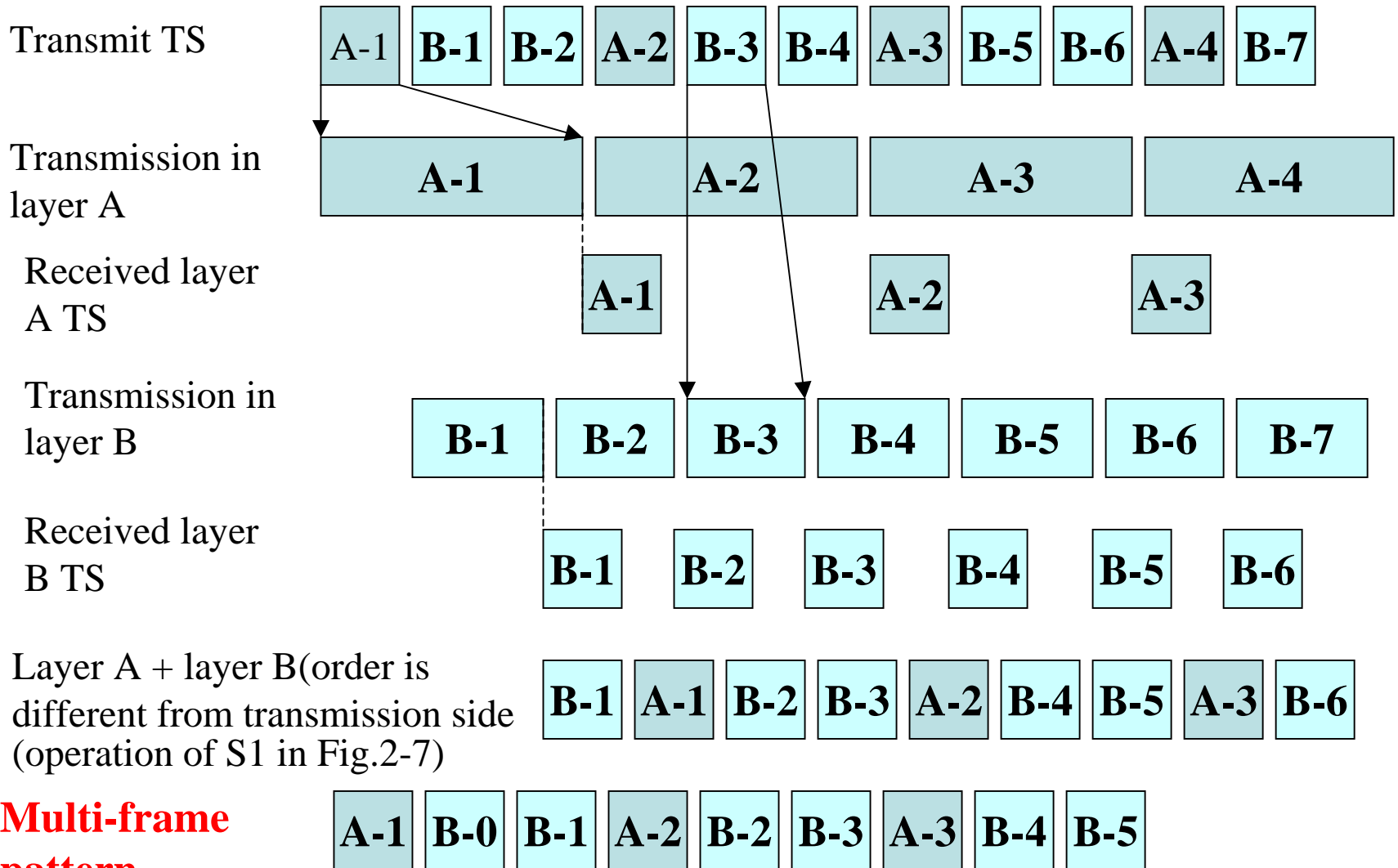


TSP's of layer A should include PCR and minimum
required PSI which are necessary to recover TSP

Fig. 2-5 Concept of hierarchical transmission

(What is multi-frame pattern)

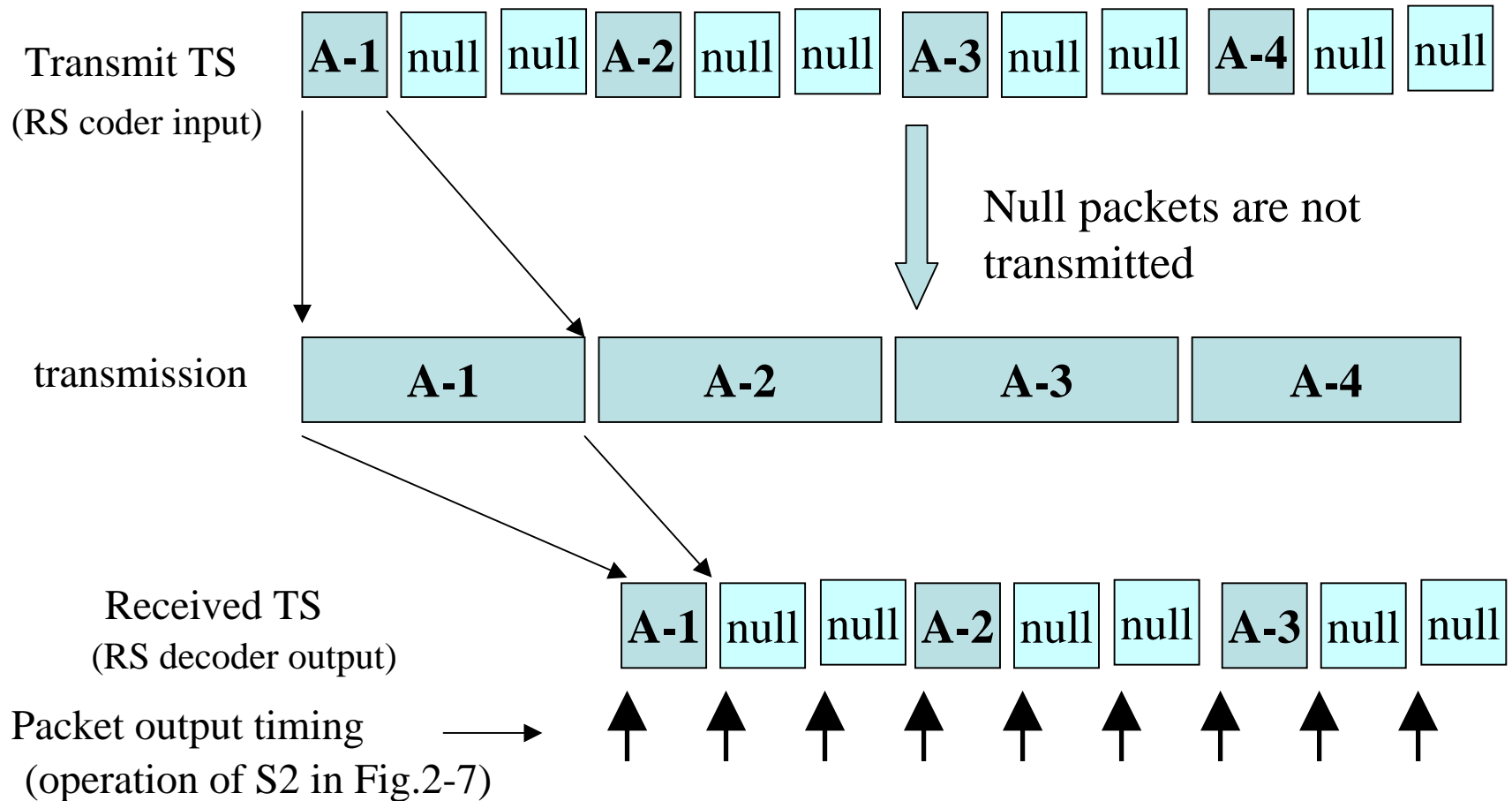
Time axis

(compensate the transmission delay difference at transmission side)

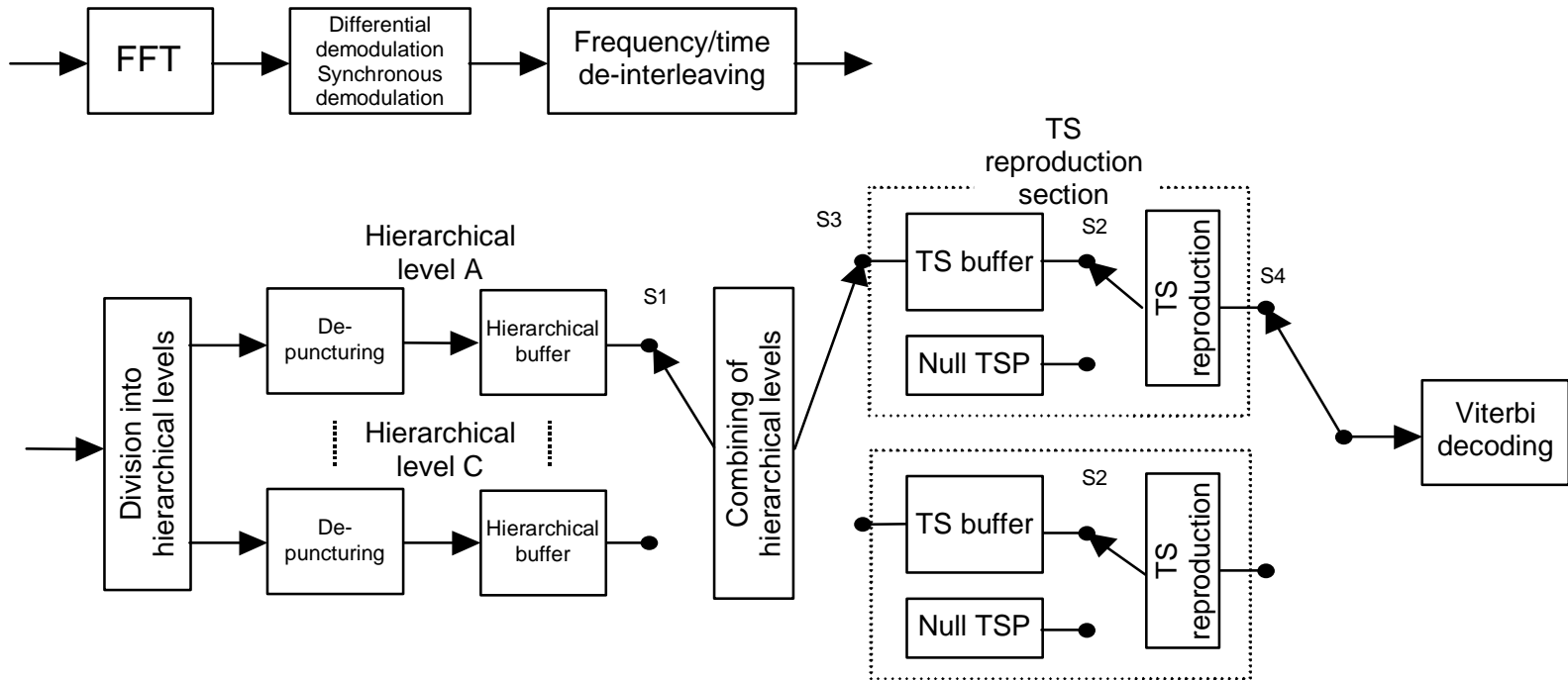
Fig. 2-6 Concept of hierarchical transmission

(How to adjust constant clock rate)



At the output portion of receiver RS decoder, TS is read by same clock rate of transmit TS (for TV, clock rate is $4f_s$). At the timing of head packet, packet does Not decoded yet, in this case, RS decoder feeds null packet. If decoded, RS decoder feeds decoded packet.

Figure 2-7 Model receiver for multi-frame reproducing



S1; select the layer. If all data of 1 packet has been input to buffer, S1 select the buffer and send data to next stage

S2; select TS/Null packet, according to TS buffer status

2.3 Segment construction and hierarchical transmission

Segment of ISDB-T is the concept for hierarchical transmission. The segment is decided as follows considering the rule shown in clause 2.2

- (1) Number of TSP in one OFDM frame is integer for all cases of transmission parameter set. Number of TSP is shown in Table 2-1.
- (2) For easy tuning operation of receiver, bandwidth of 1 segment is set to 6/14 MHz.
- (3) Number of multi-frame pattern is proportional to number of set of hierarchy. For this reason, number of hierarchy is limited as many as 3.

Table 2-1 Number of TSP in one OFDM frame

(mode 1)

coding rate modulation	1/2	2/3	3/4	5/6	7/8
DQPSK/QPSK	12	16	18	20	21
16QAM	24	32	36	40	42
64QAM	36	48	54	60	63

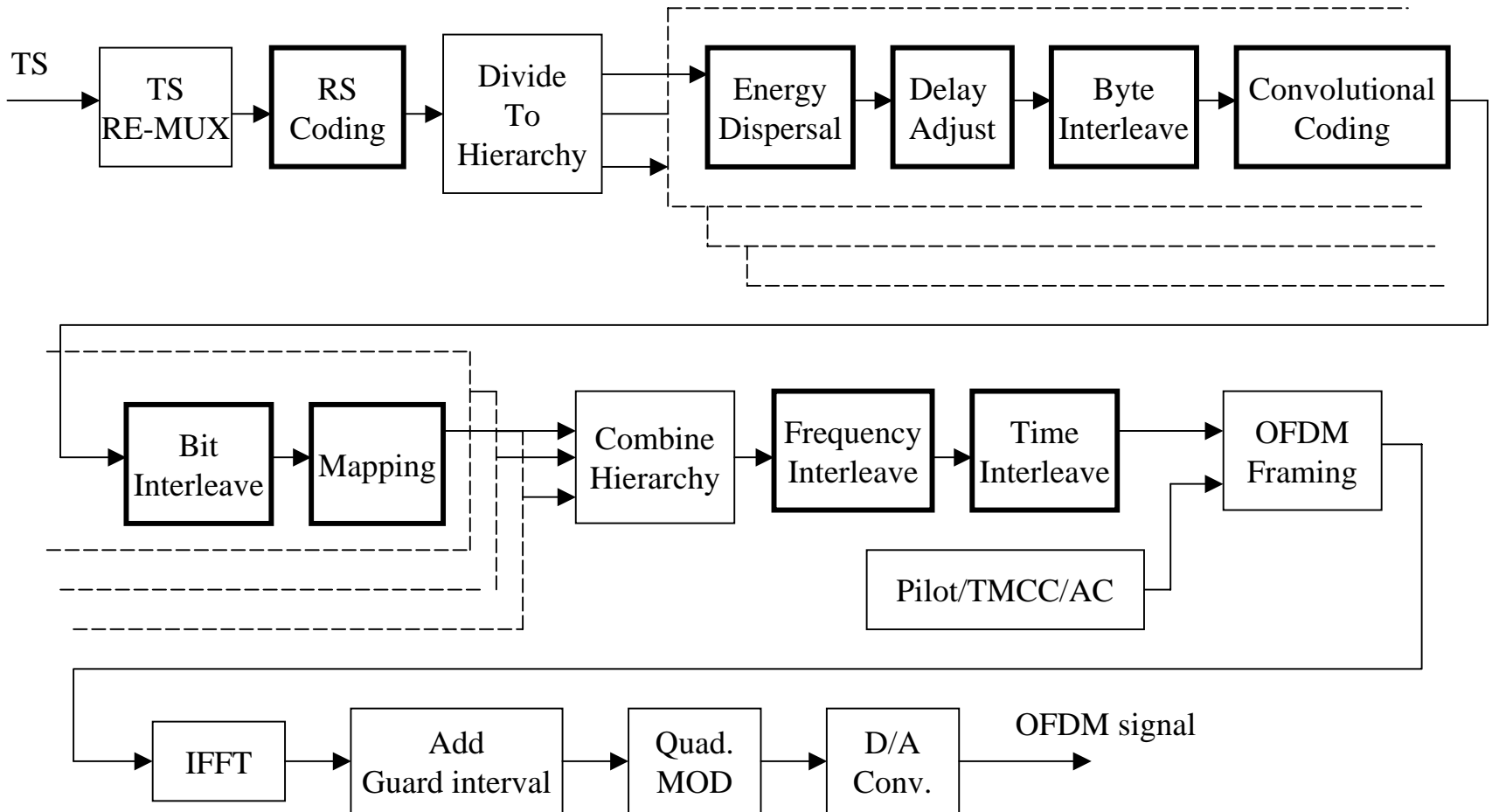
(note1) number of TSP/segment

(note 2) in case of mode 2 , number of TSP is twice , and in case of mode 3, four times

3. Channel coding

Relating clause of ARIB standard; B31 clause 3.3 – clause 3.11

Blockdiagram of ISDB-T Transmission coding



These functions are presented in this section

Outer coder (Reed-Solomon coding)

A shortened Reed-Solomon code (204,188) is used in every TSP as an outer code. The shortened Reed-Solomon (204,188) code is generated by adding 51-byte 00HEX at the beginning of the input of the data bytes of Reed-Solomon (255,239) code, and then removing these 51 bytes.

The GF (28) element is used as the Reed-Solomon code element. The following primitive polynomial $p(x)$ is used to define GF (28):

$$p(x) = x^8 + x^4 + x^3 + x^2 + 1$$

Note also that the following polynomial $g(x)$ is used to generate (204,188) shortened Reed-Solomon code:

$$g(x) = (x - \lambda_0)(x - \lambda_1)(x - \lambda_2) \dots (x - \lambda_{15}) \text{ provided that } \lambda = 02 \text{ HEX}$$

Sync. 1 byte	Data (187 bytes)	(a) MPEG-2 TSP
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Sync. 1 byte	Data (187 bytes)	Parity 16 byte
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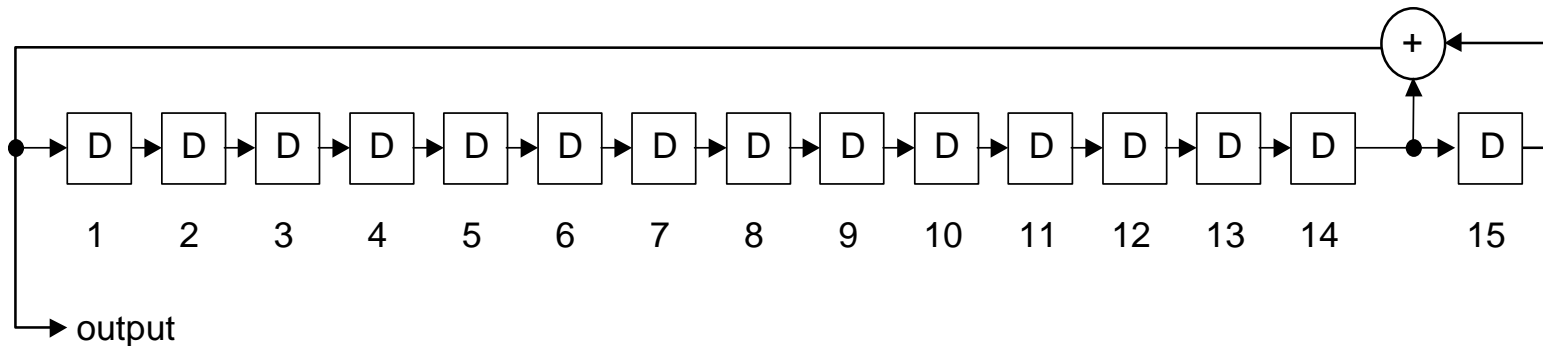
(b) TSP error-protected by RS code (transmission TSP)

MPEG2 TSP and Transmission TSP(B31, Fig. 3-6)

Energy Dispersal

Energy dispersal is conducted at each hierarchical layer using a circuit, shown in Fig. 3-8, that is generated by a PRBS (Pseudo Random Bit Sequence). All signals other than the synchronization byte in each of the transmission TSPs at different hierarchical layers are EXCLUSIVE ORed using PRBSs, on a bit-by-bit basis.

$$g(x) = X^{15} + X^{14} + 1$$



PRBS-Generating Polynomial and Circuit (B31, Fig. 3-8)

Inner coding

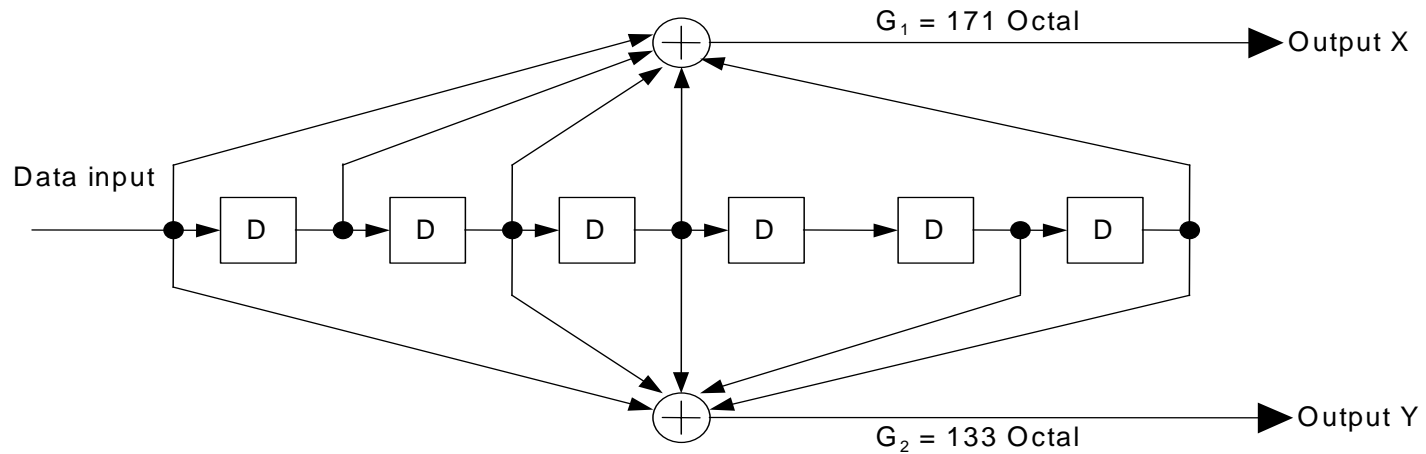
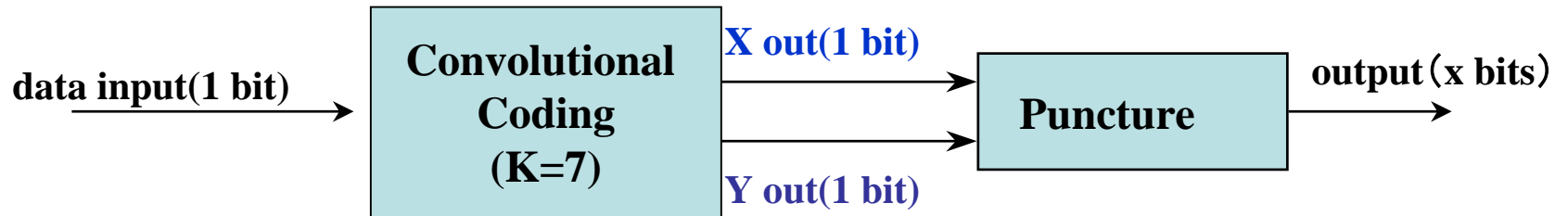


Fig. 3-10: Coding Circuit of a Convolutional Code with Constraint Length k of 7 and a Coding Rate of $1/2$

Coding rate	Puncturing pattern	Transmission-signal sequence
$1/2$	X : 1 Y : 1	X1, Y1
$2/3$	X : 1 0 Y : 1 1	X1, Y1, Y2
$3/4$	X : 1 0 1 Y : 1 1 0	X1, Y1, Y2, X3
$5/6$	X : 1 0 1 0 1 Y : 1 1 0 1 0	X1, Y1, Y2, X3 Y4, X5
$7/8$	X : 1 0 0 0 1 0 1 Y : 1 1 1 1 0 1 0	X1, Y1, Y2, Y3, Y4, X5, Y6, X7

Table 3-8: Inner-Code Coding Rates and Transmission-Signal Sequence

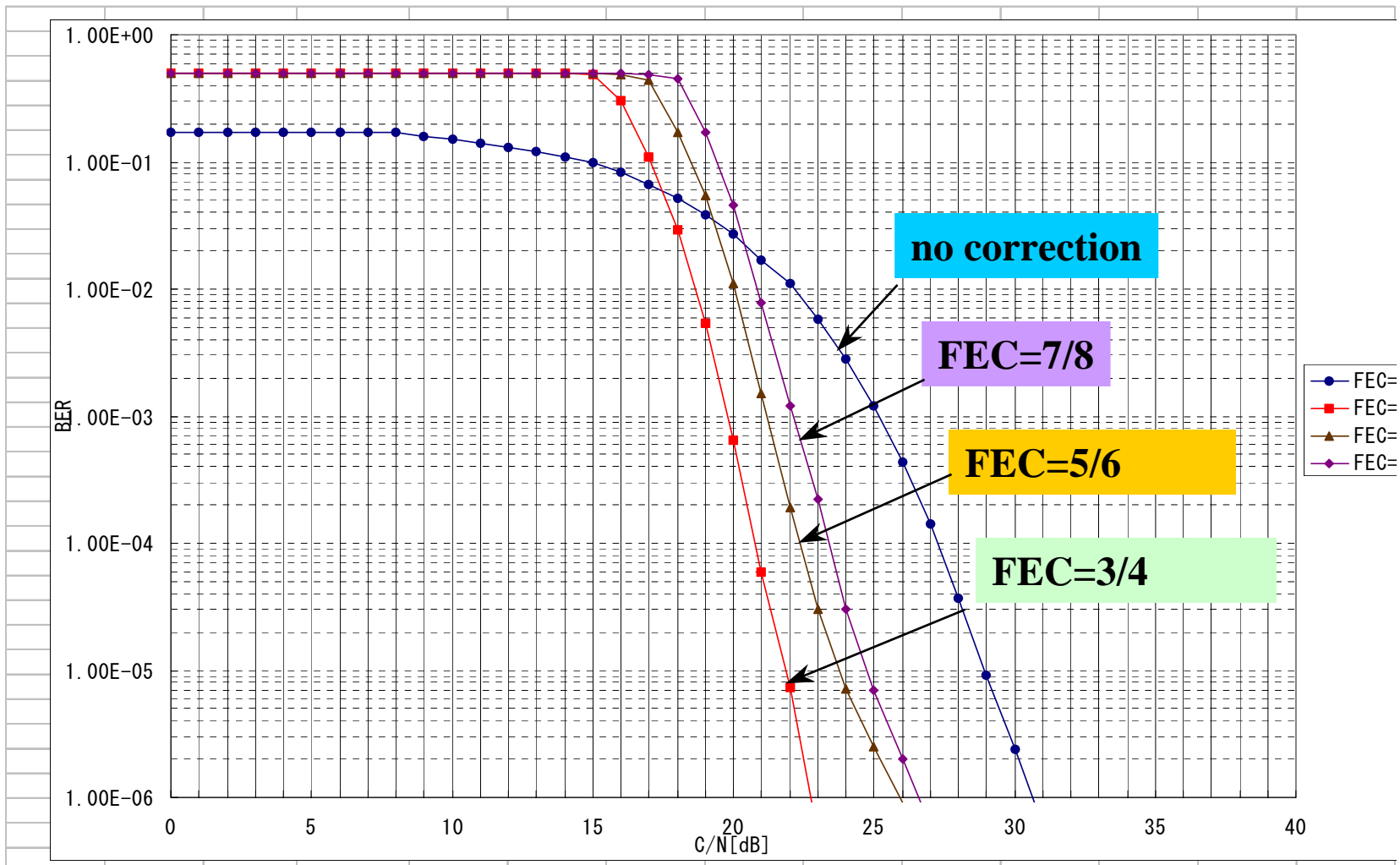
Puncturing Pattern



coding rate	Number of input bits	Number of output bits	Puncturing pattern	Output of puncturing
1/2	1	2	X:1 Y:1	X1, Y1 (2)
2/3	2	4	X: 1 <u>0</u> Y: 11	X1, Y1, Y2 (3)
3/4	3	6	X: 1 <u>0</u> 1 Y: 11 <u>0</u>	X1, Y1, Y2, Y3 (4)
5/6	5	10	X: 1 <u>0</u> 1 <u>0</u> 1 Y: 11 <u>0</u> 1 <u>0</u>	X1, Y1, Y2, Y3, Y4, Y5 (6)
7/8	7	14	X: 10001 <u>0</u> 1 Y: 1111 <u>0</u> 1 <u>0</u>	X1, Y1, Y2, Y3, Y4, Y5, Y6, Y7 (8)

Example of input C/N vs BER characteristics

Mode;1 GI=1/8, 64QAM, I=0, RS;OFF



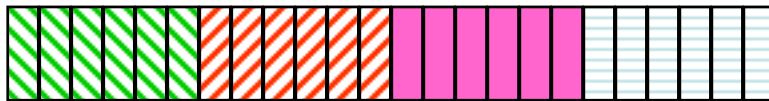
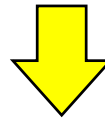
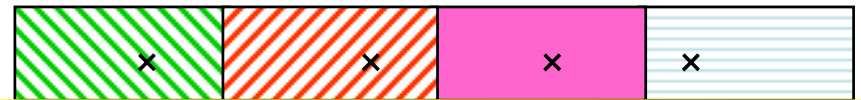
Effect of interleave

Interleave is one of important technology in transmission system.
Error correction system is most effective when the characteristics of noise is random.
The purpose of interleave is to randomize the burst error occurred in transmission path

Burst error; FEC does not work well



Random error; FEC works well



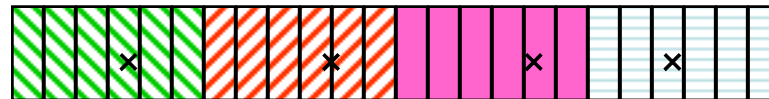
transmitter before interleave



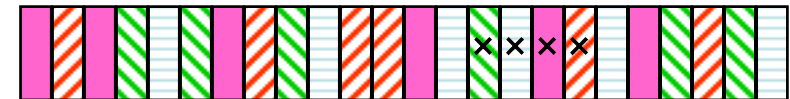
transmitter after interleave

interleave

Burst error occurs at transmission path



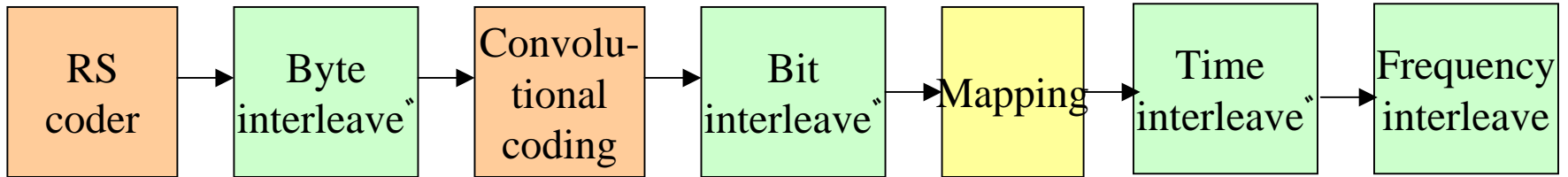
receiver after de-interleave



receiver before de-interleave

de-interleave

Kind of interleave and these effect



Byte interleave

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

Bit interleave

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

Time interleave

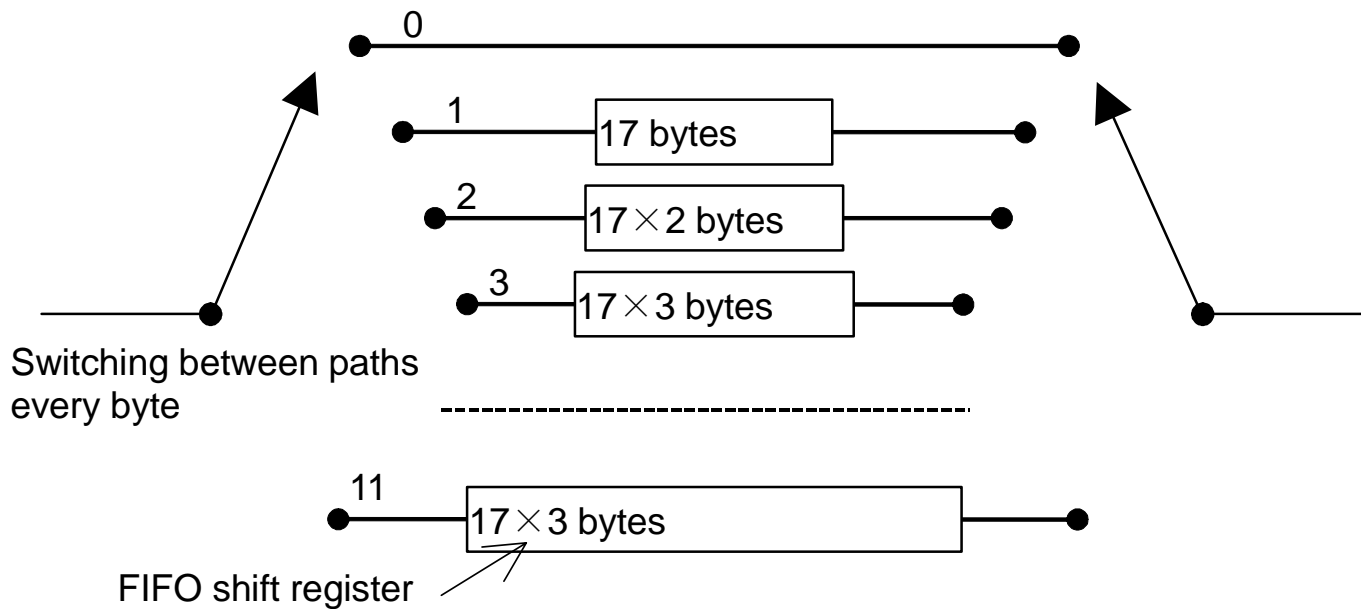
Frequency interleave is located at the output of frequency interleaver. Randomize the burst error of time domain which is mainly caused by impulse noise, fading of mobile reception, etc.

Frequency interleave

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

Byte interleave

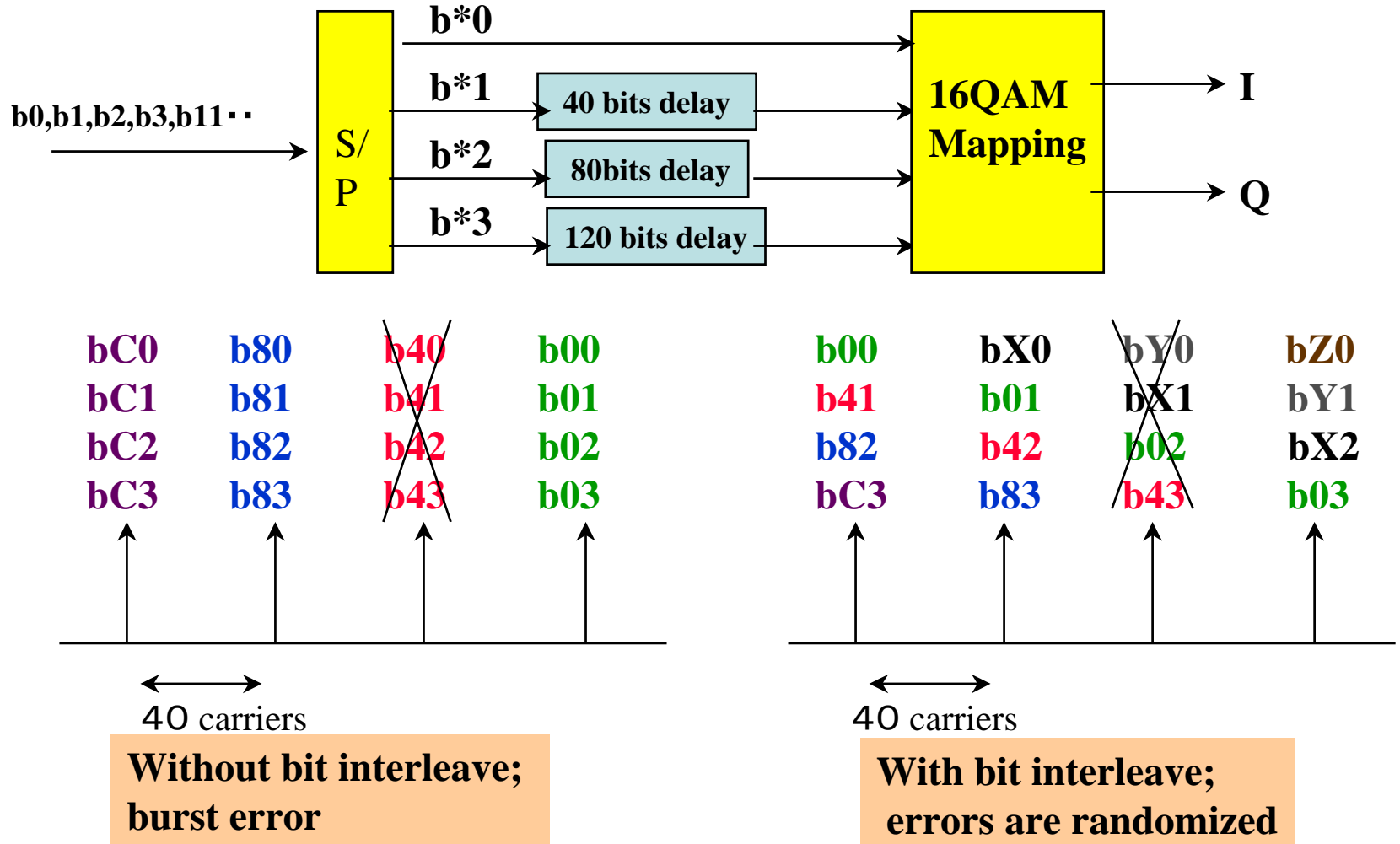
The 204-byte transmission TSP, which is error-protected by means of RS code and energy-dispersed, undergoes convolutional byte interleaving. Interleaving must be 12 bytes in depth. Note, however, that the byte next to the synchronization byte must pass through a reference path that causes no delay.



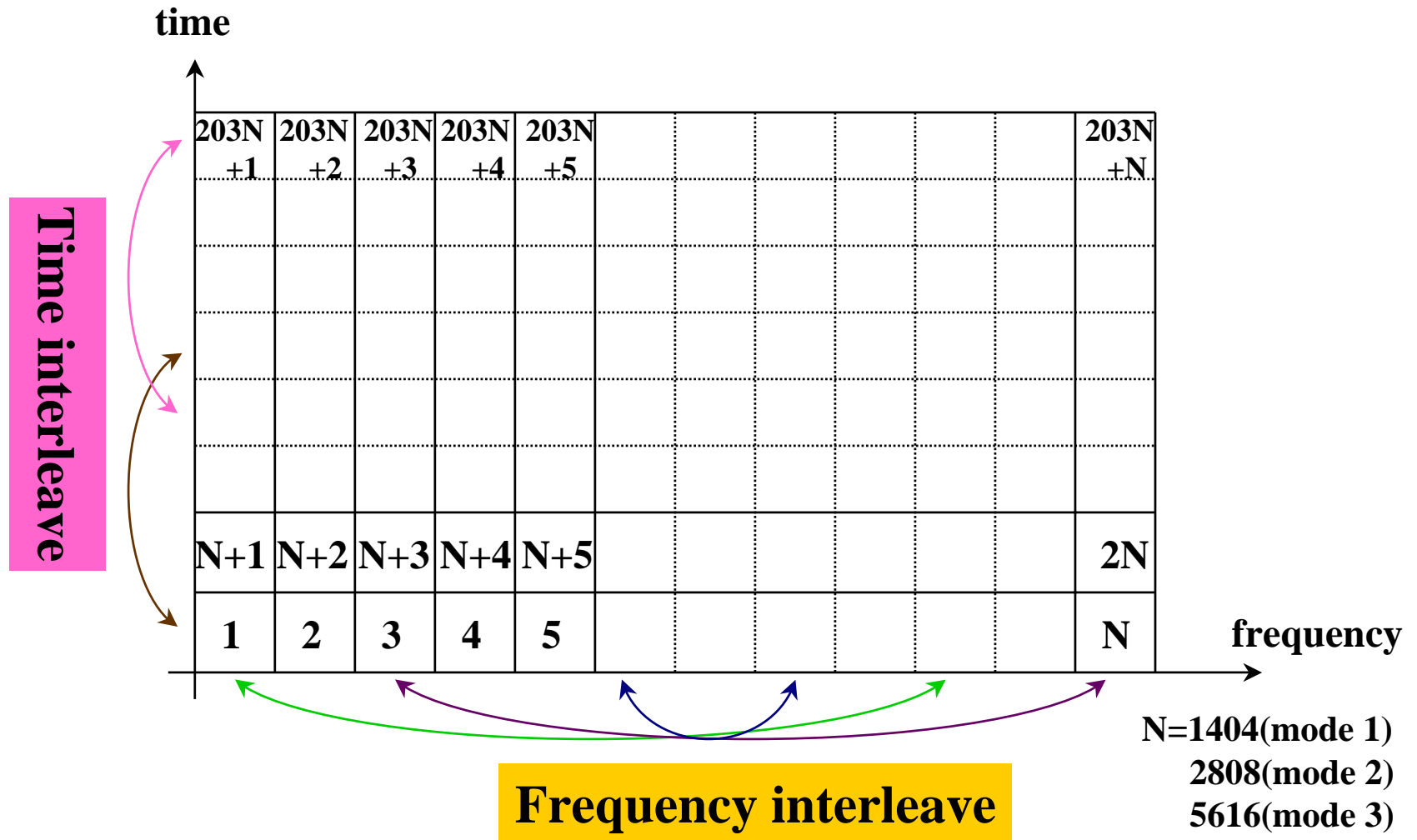
Bit interleave

(B31, clause 3.9.3)

Bit interleave circuit is different according to carrier modulation. Following diagram is an example of 16QAM.

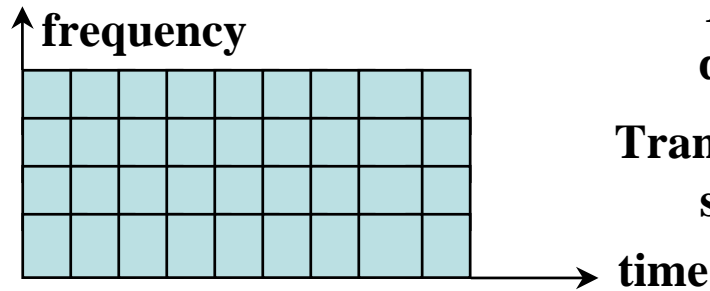


Relation between OFDM frame and interleave



Effect of time interleave

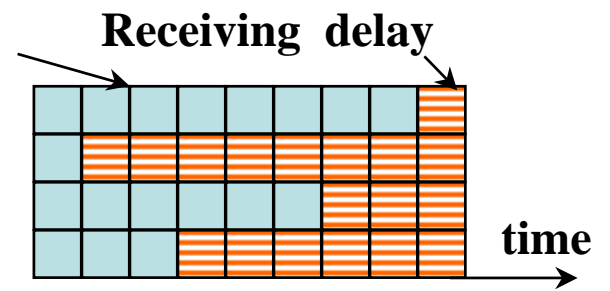
no time interleave



Transmitting delay

Transmitter side

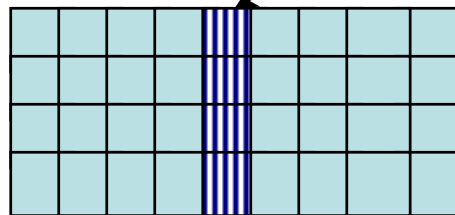
With time interleave



field strength varied



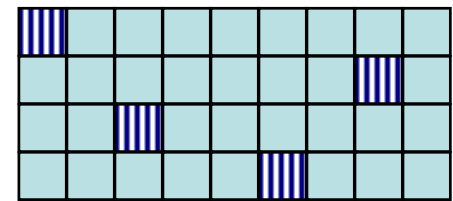
Error symbol



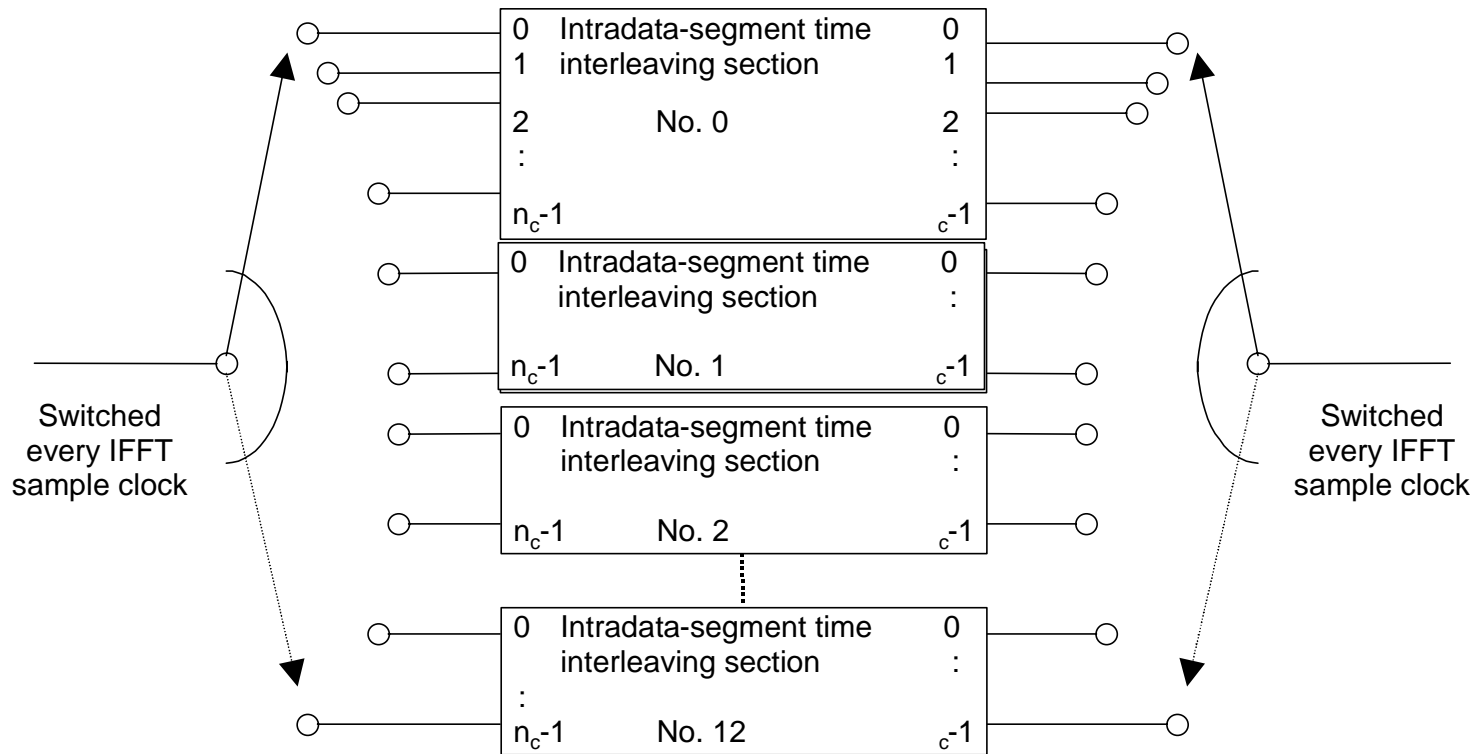
Burst error



receiver side
(After de-interleave)



Error randomized



Time interleaver blockdiagram(B31, 3.11.1)

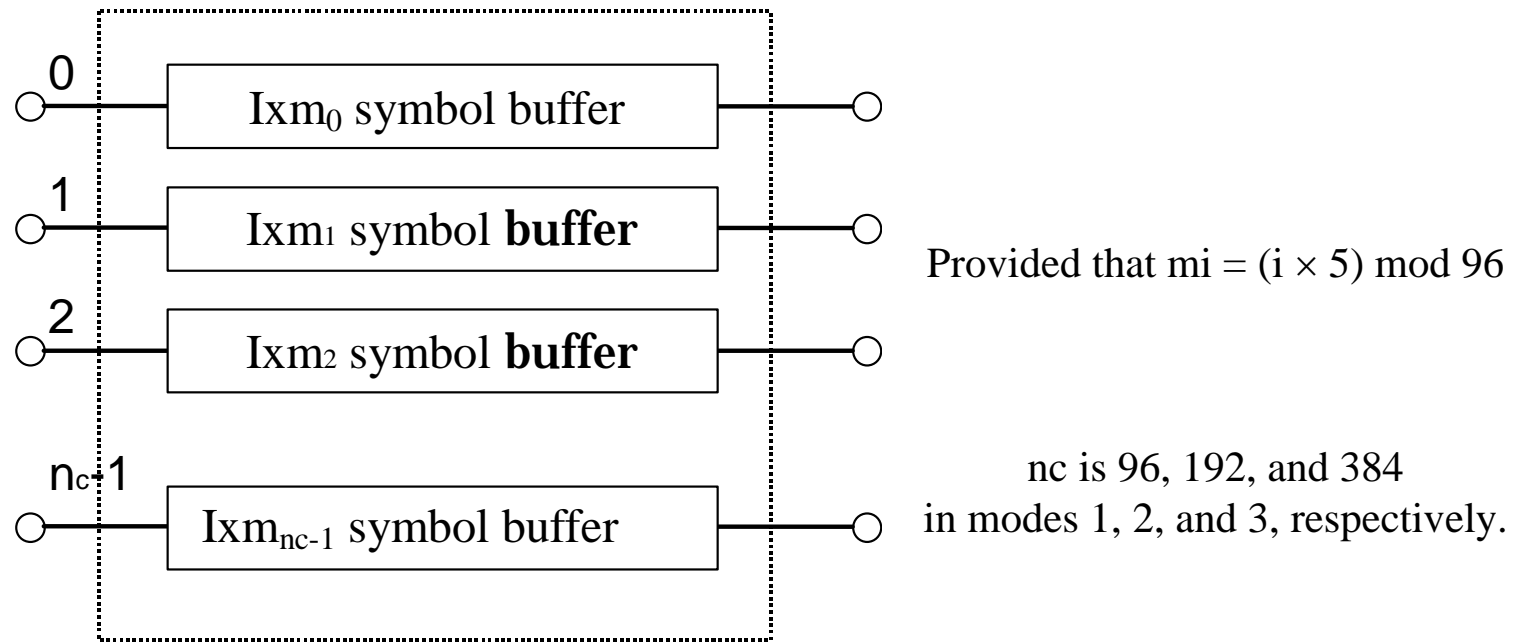


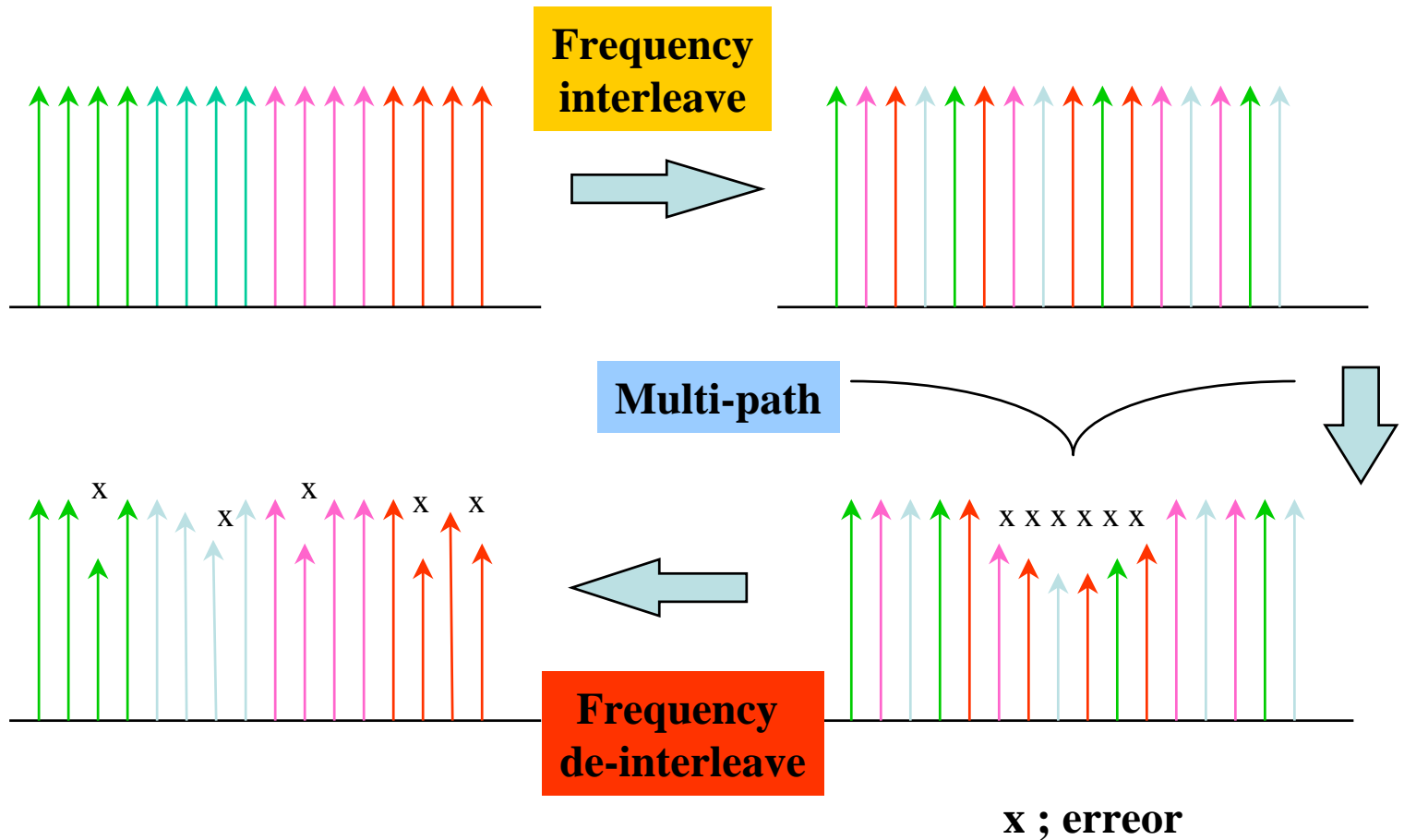
Fig. 3-23: Configuration of the Intra-segment Time Interleaving Section

Table 3-12: Time Interleaving Lengths and Delay Adjustment Values

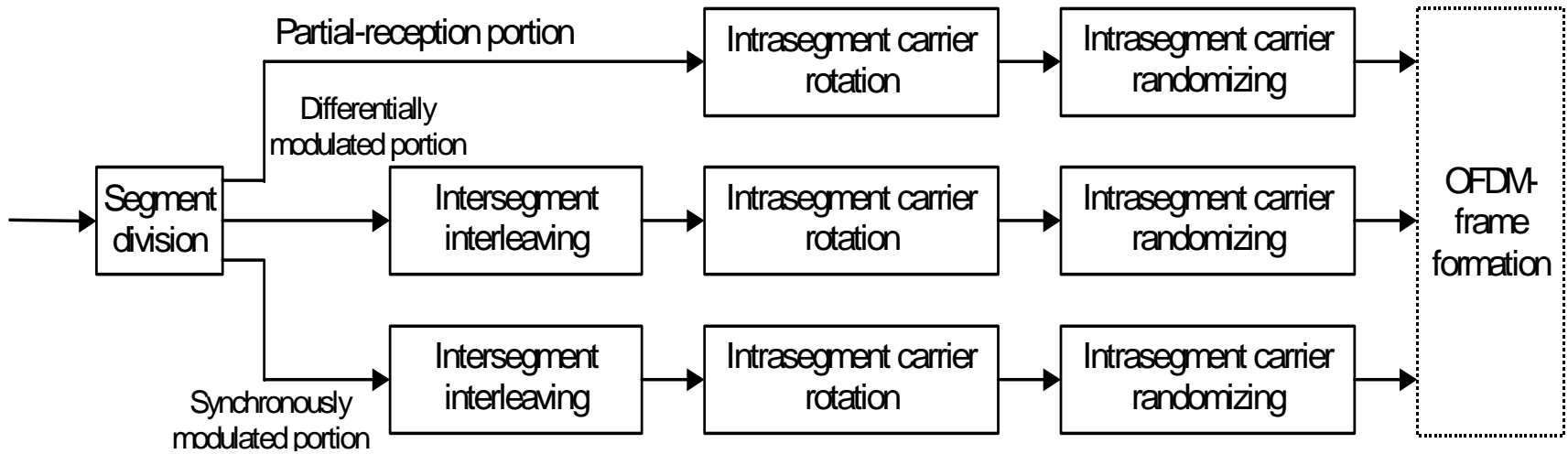
Mode 1			Mode 2			Mode 3		
Length (I)	Number of delay-adjustment symbols	Number of delayed frames in transmission and reception	Length (I)	Number of delay-adjustment symbols	Number of delayed frames in transmission and reception	Length (I)	Number of delay-adjustment symbols	Number of delayed frames in transmission and reception
0	0	0	0	0	0	0	0	0
4	28	2	2	14	1	1	109	1
8	56	4	4	28	2	2	14	1
16	112	8	8	56	4	4	28	2

(Notification)

Effect of frequency interleave



Multi-path causes low power frequency area, where multi-path wave is inverse phase of direct path wave.



Configuration of frequency interleaving section

The input signal must be 2 bits per symbol and QPSK-mapped to output multi-bit I- and Q-axes data. To conduct mapping, the 120-bit delay element shown in Fig. 3-14 is inserted into the mapping input for bit interleaving.

Figs. 3-14 and 3-15 show the system diagram and mapping constellation, respectively.

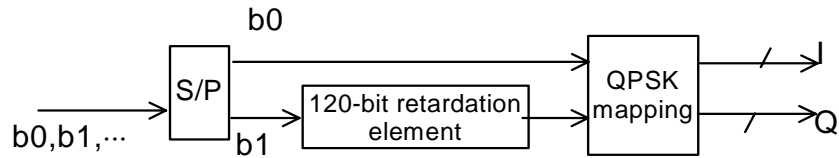


Fig. 3-14: QP 120-bit delay element System Diagram

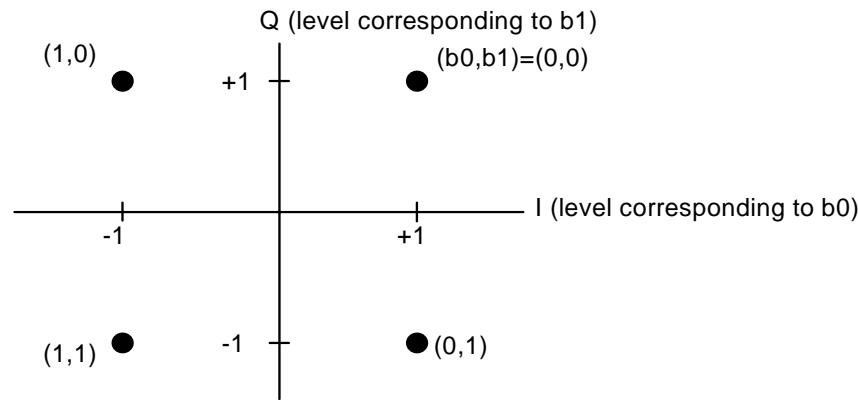


Fig. 3-15: QPSK Constellation

Mapping

The input signal must be 4 bits per symbol and 16QAM-mapped to output multi-bit I- and Q- axes data. To conduct mapping, the delay elements shown in Fig. 3-16 are inserted into b1 to b3 for bit interleaving.

Figs. 3-16 and 3-17 show the system diagram and mapping constellation, respectively.

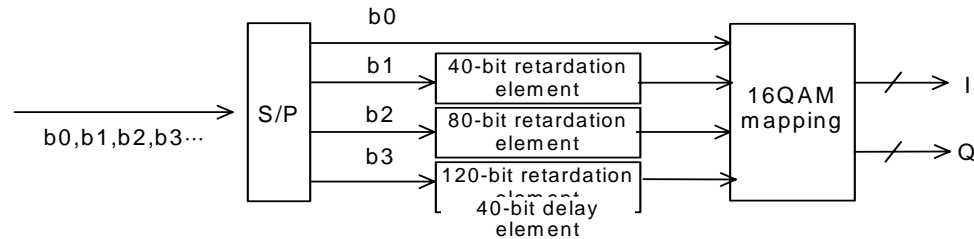


Fig. 3-16: 16QAM System Diagram

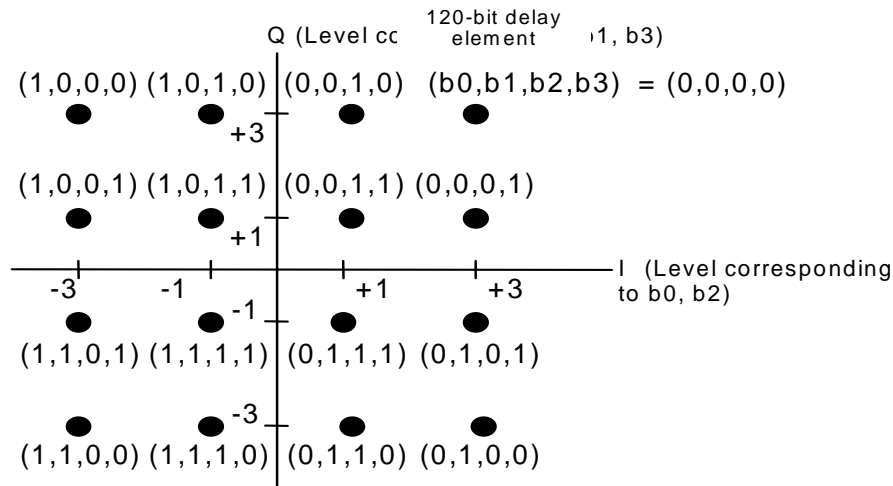


Fig. 3-17: 16QAM Constellation

Mapping

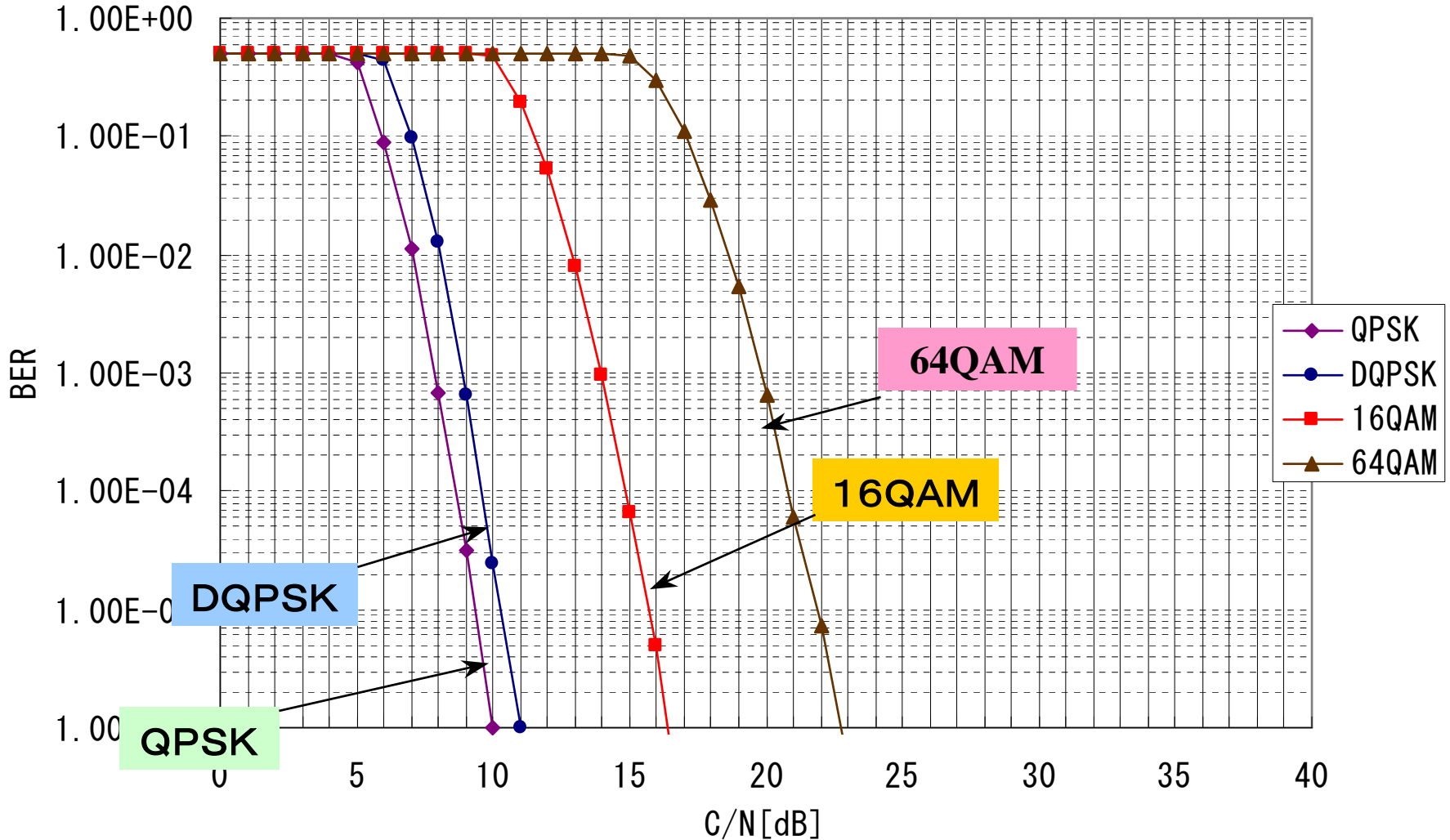
Required C/N (dB) (note)

Modulation	Coding rate				
	1/2	2/3	3/4	5/6	7/8
QPSK	4.9	6.6	7.5	8.5	9.1
DQPSK	6.2	7.7	8.7	9.6	10.4
16QAM	11.5	13.5	14.6	15.6	16.2
64QAM	16.5	18.7	20.1	21.3	22.0

(note) after Viterbi decoding, BER is as much as 2×10^{-4}

Input C/N vs BER characteristics

Mode; 1, GI=1/8 FEC=3/4, RS=OFF

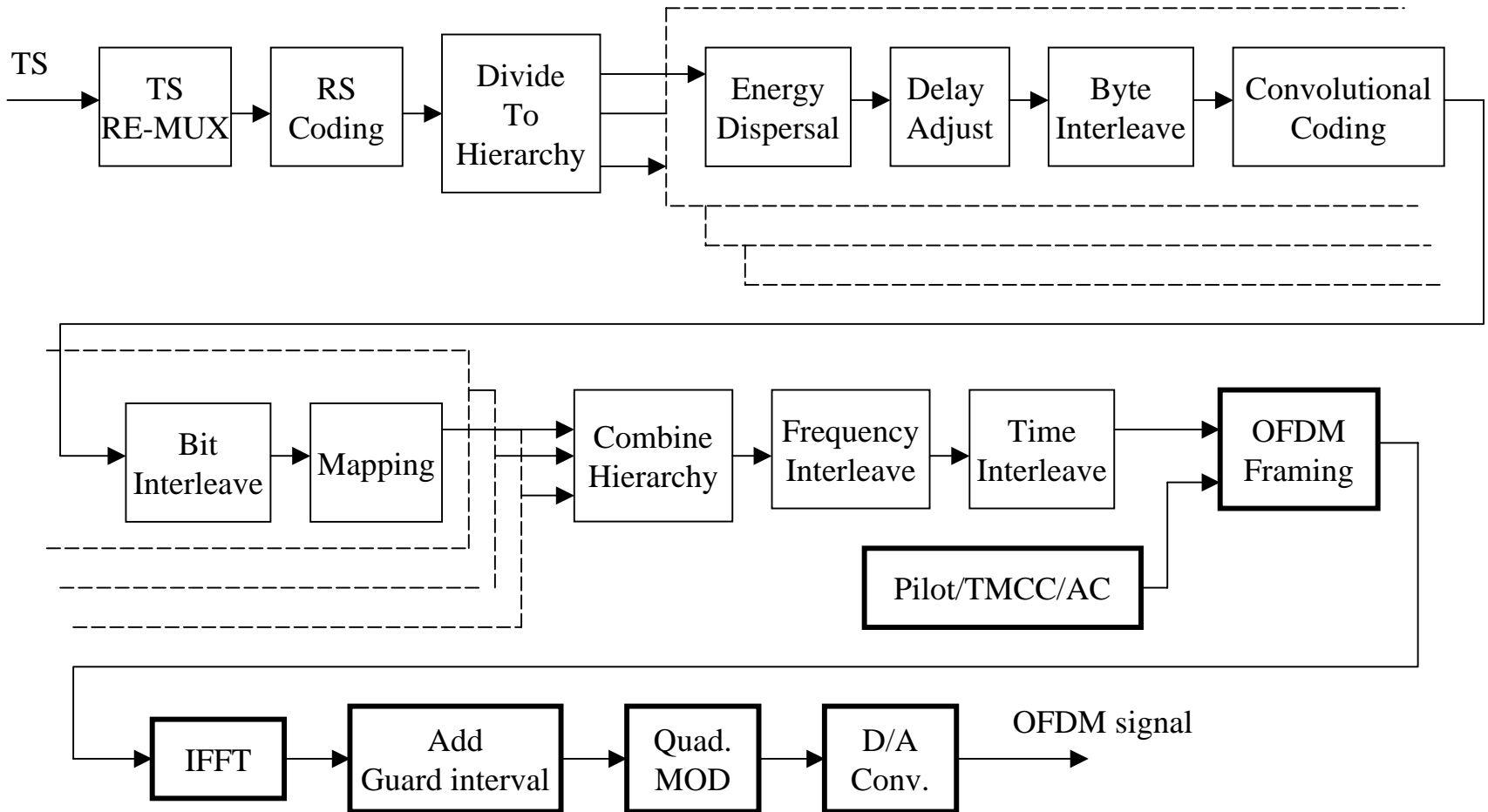


4. OFDM modulation

- (1) IFFT
- (2) Pilot signal
- (3) AC
- (4) TMCC
- (5) Guard interval
- (6) Quad. Modulation and RF format

Relating clause of ARIB standard; B31 clause 3.12 – clause 3.15

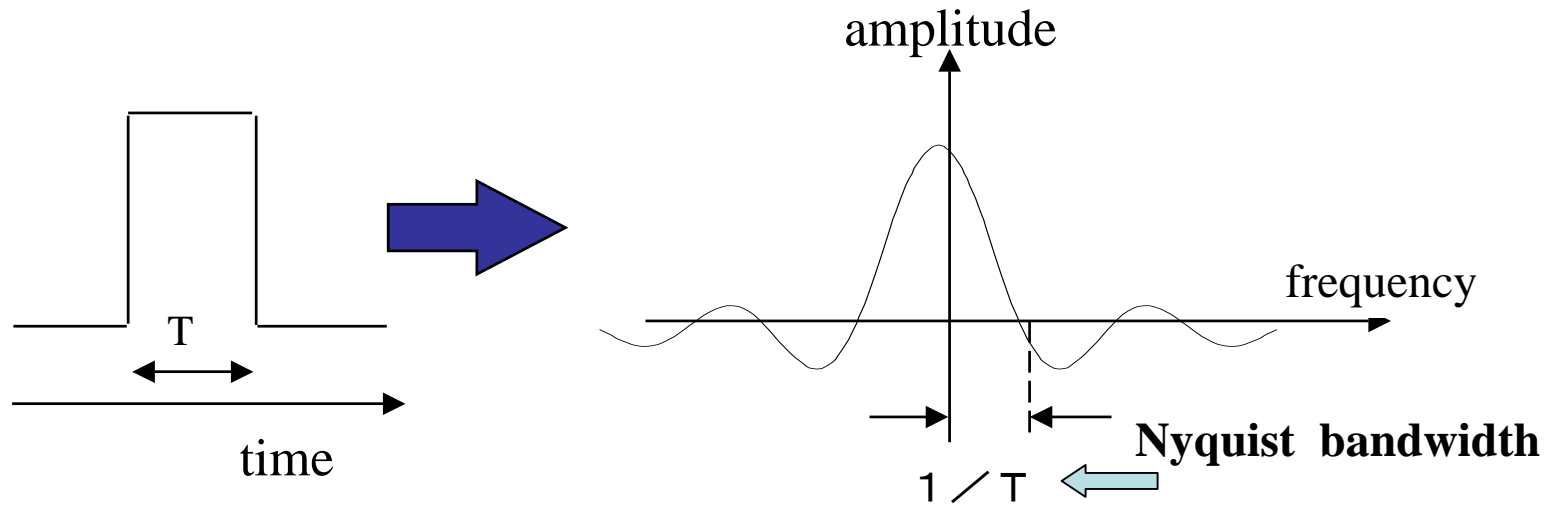
Blockdiagram of ISDB-T Transmission coding



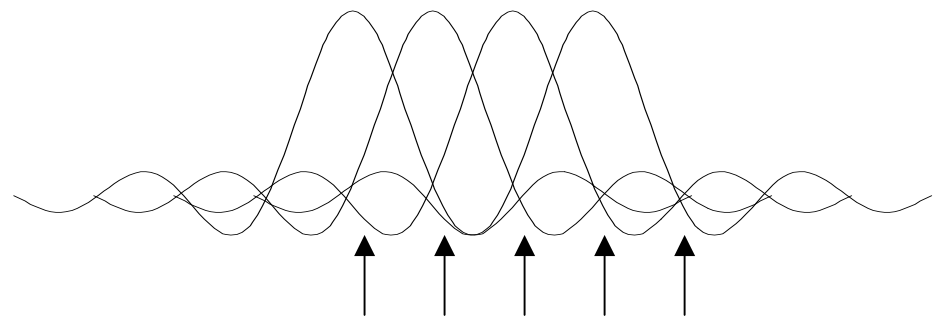
These functions are presented in this section

Nyquist separation and orthogonal FDM

Fourier transform and inverse FFT

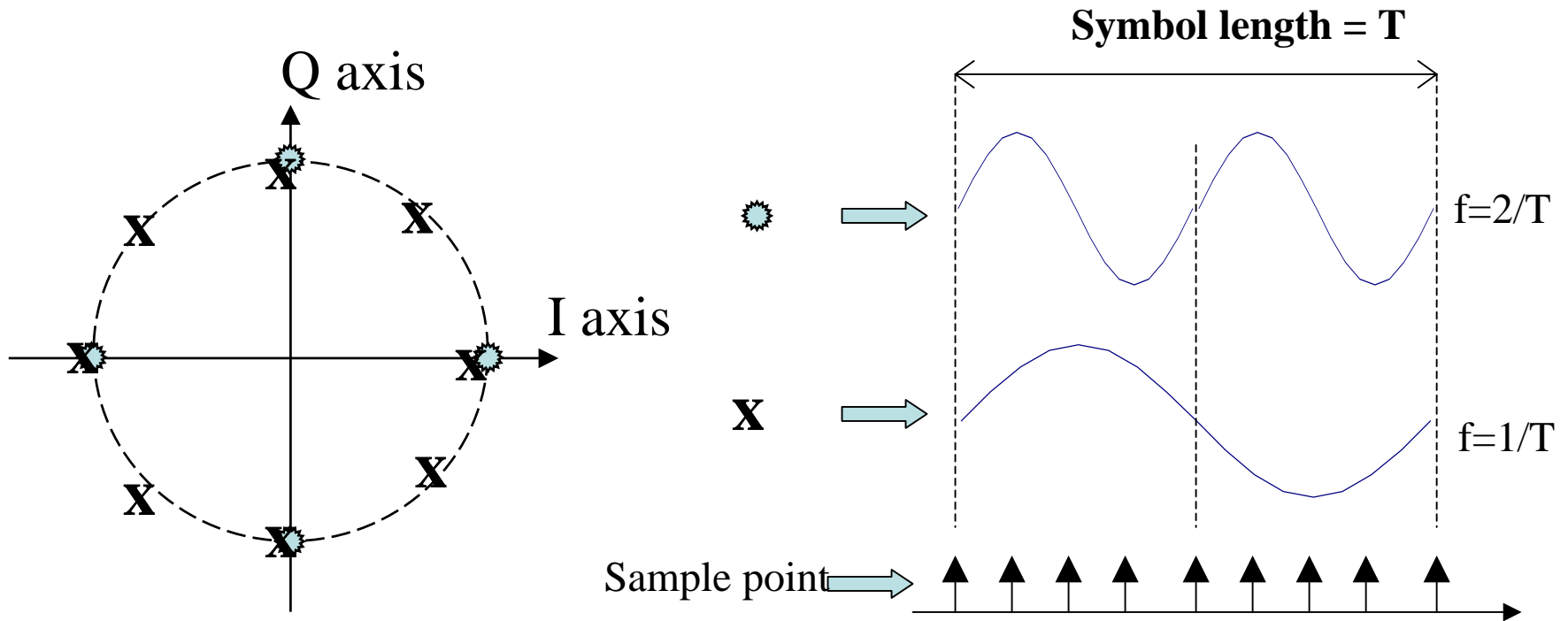


Orthogonal division multiplex



At the adjacent carrier position, all other carrier energy is zero.

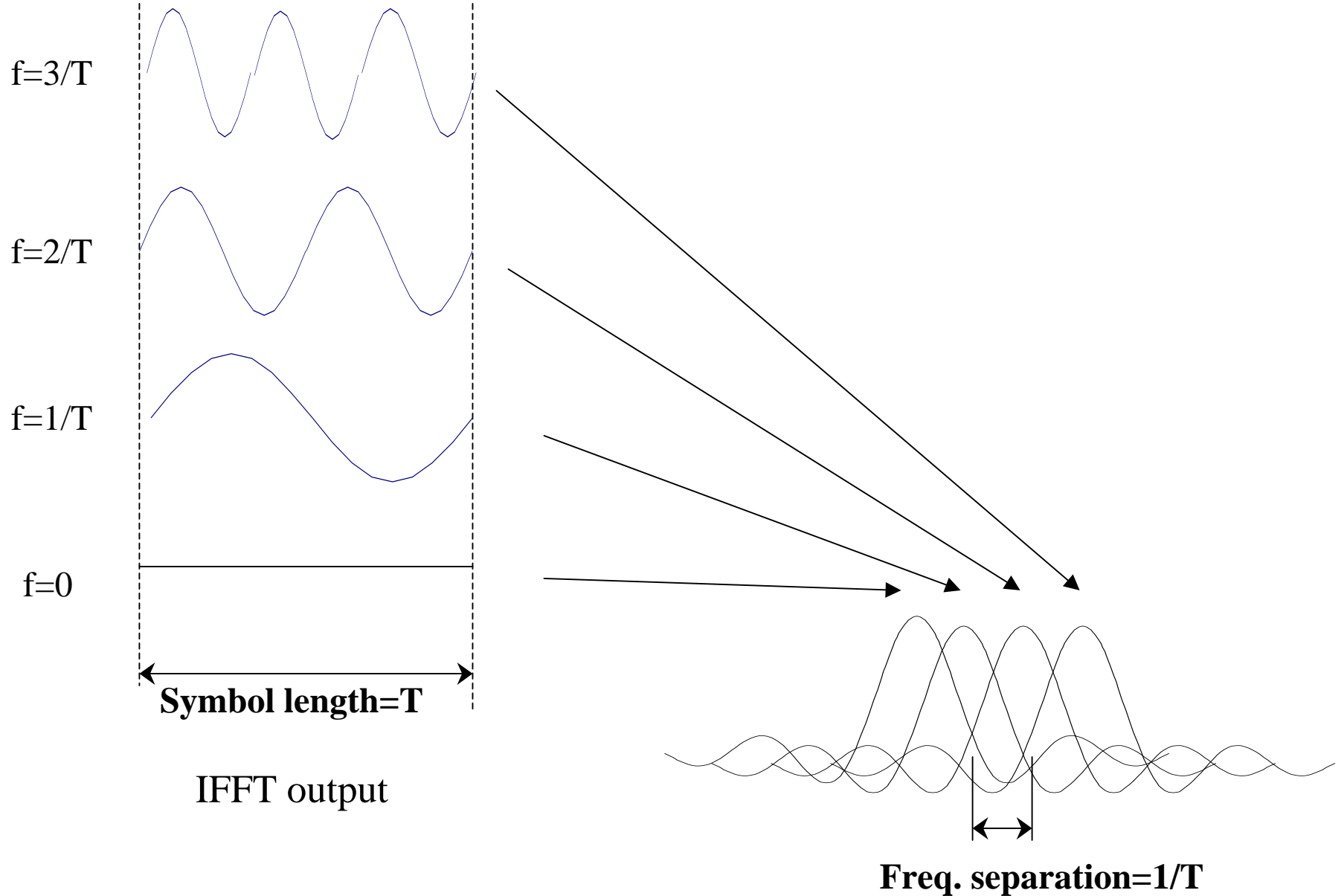
OFDM signal generation by IFFT

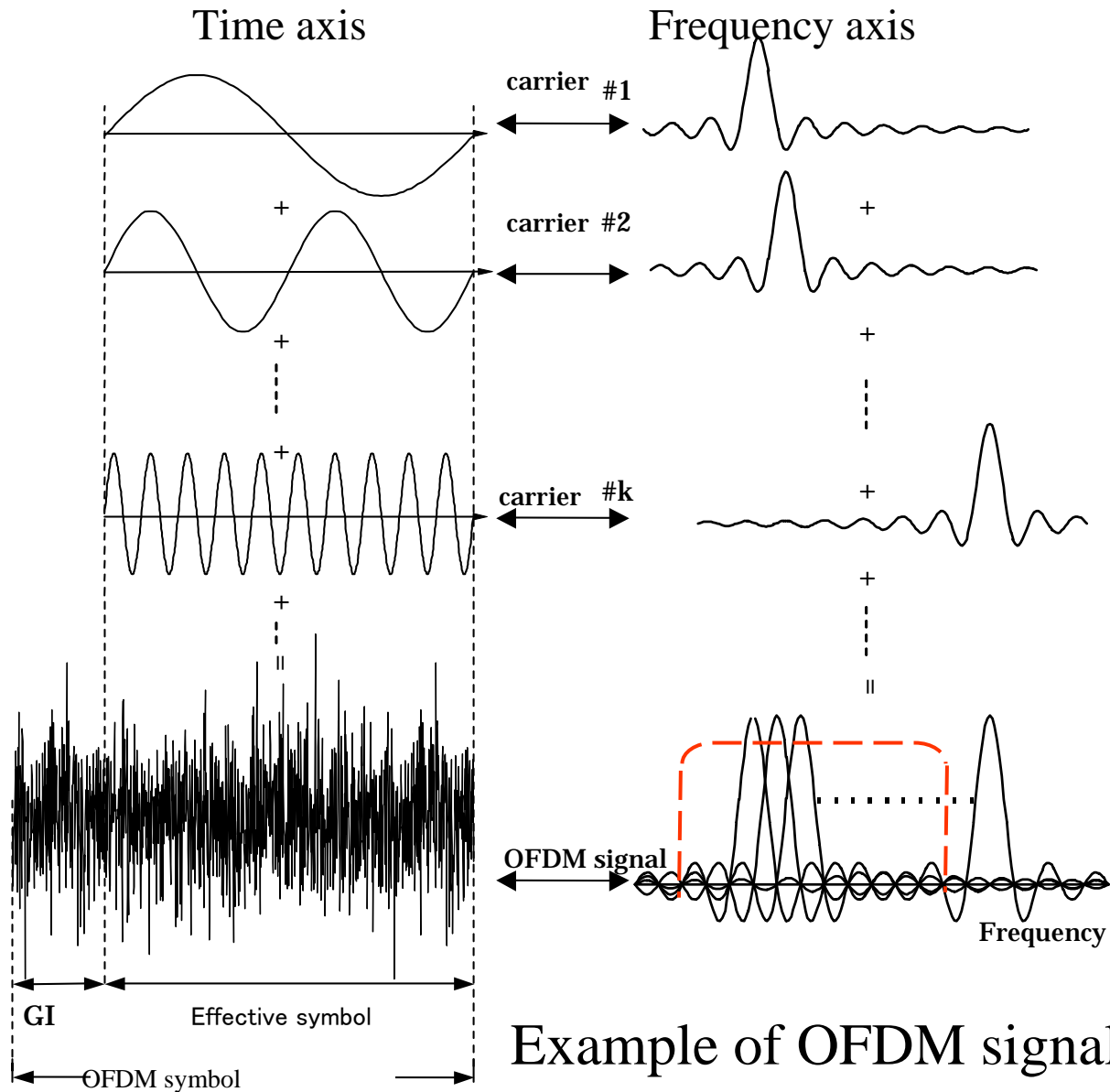


X; Sample point to generate sine wave of $f=1/T$ cycle

⊛ Sample point to generate sine wave of $f=2/T$ cycle

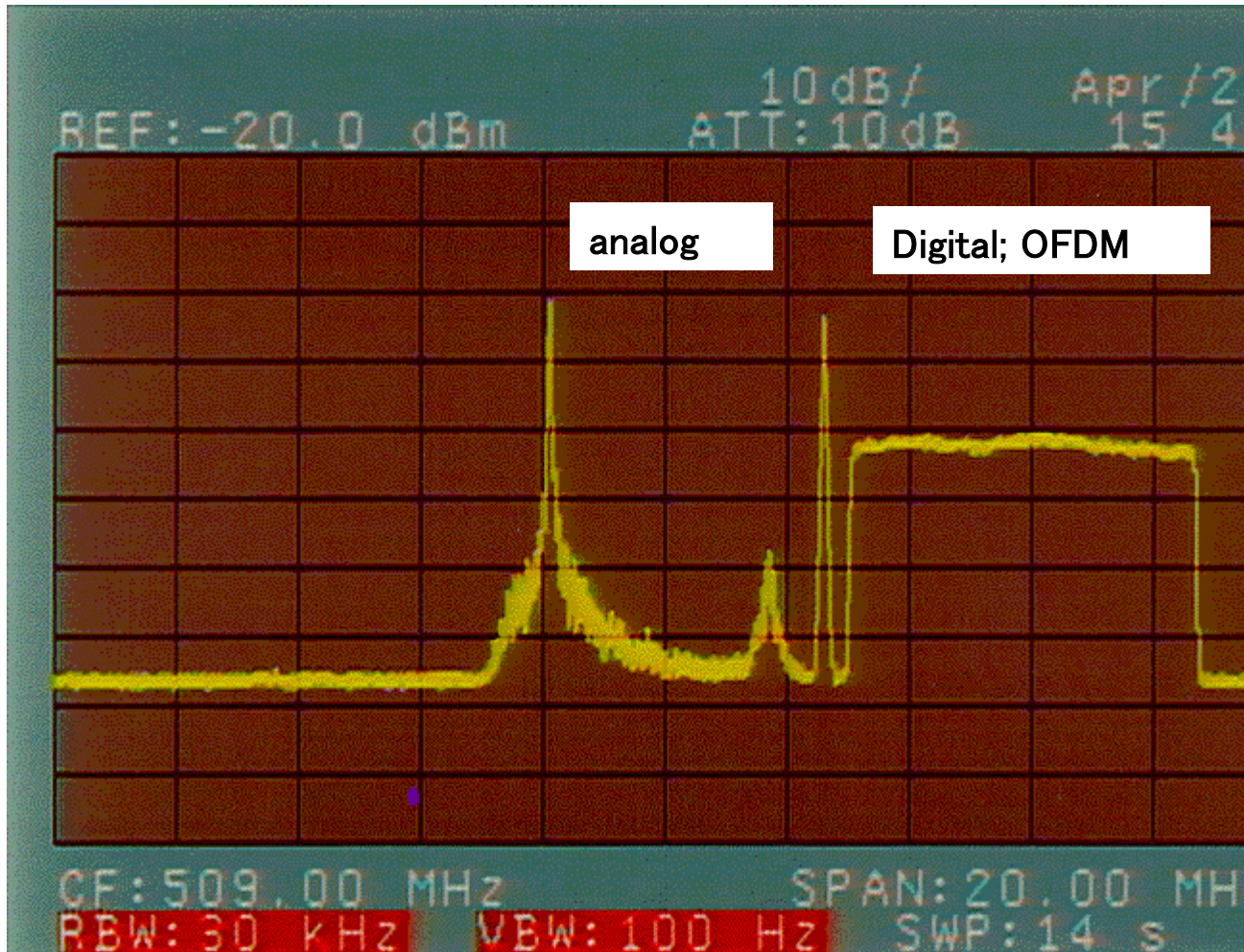
IFFT output and frequency allocation



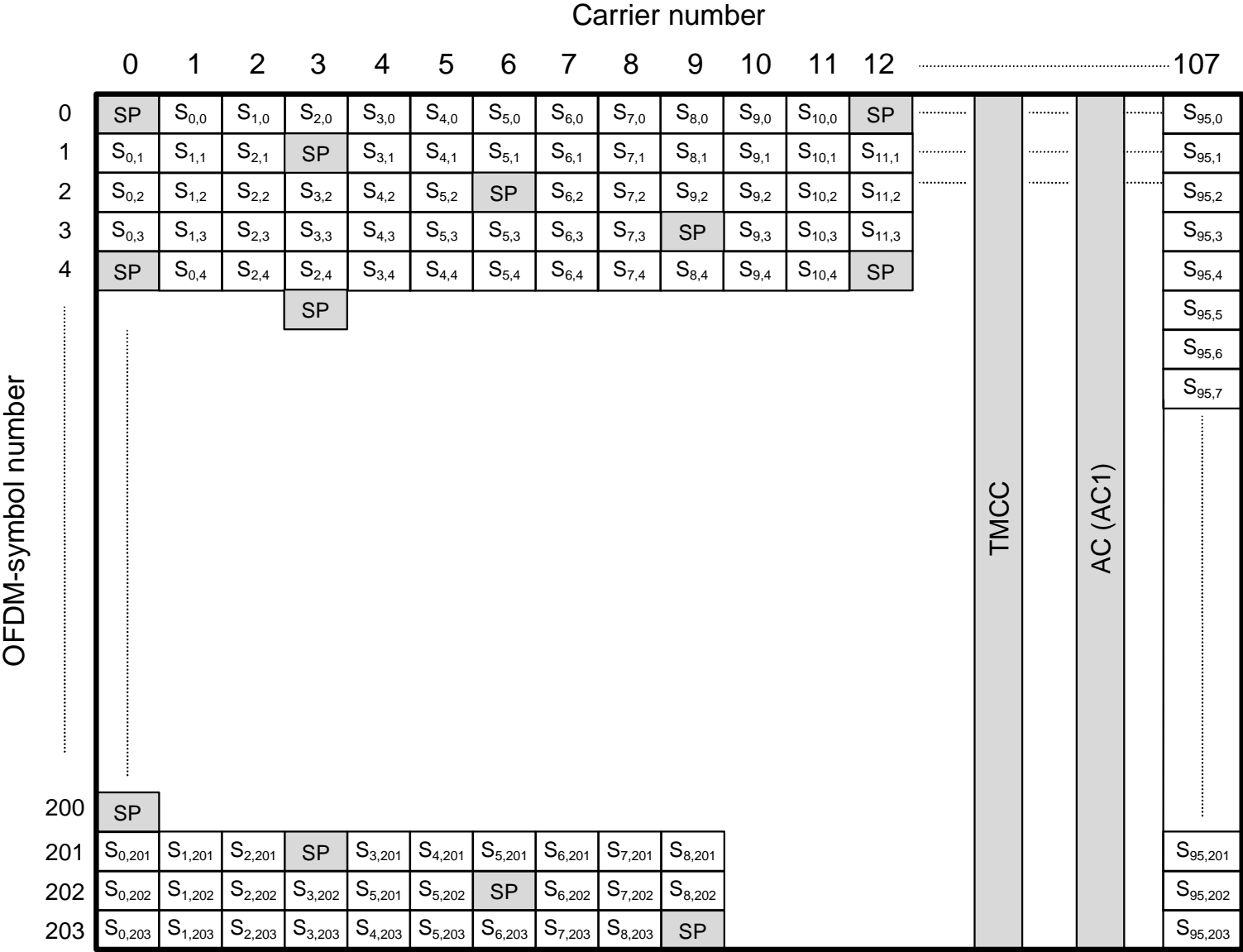


Example of OFDM signal waveform

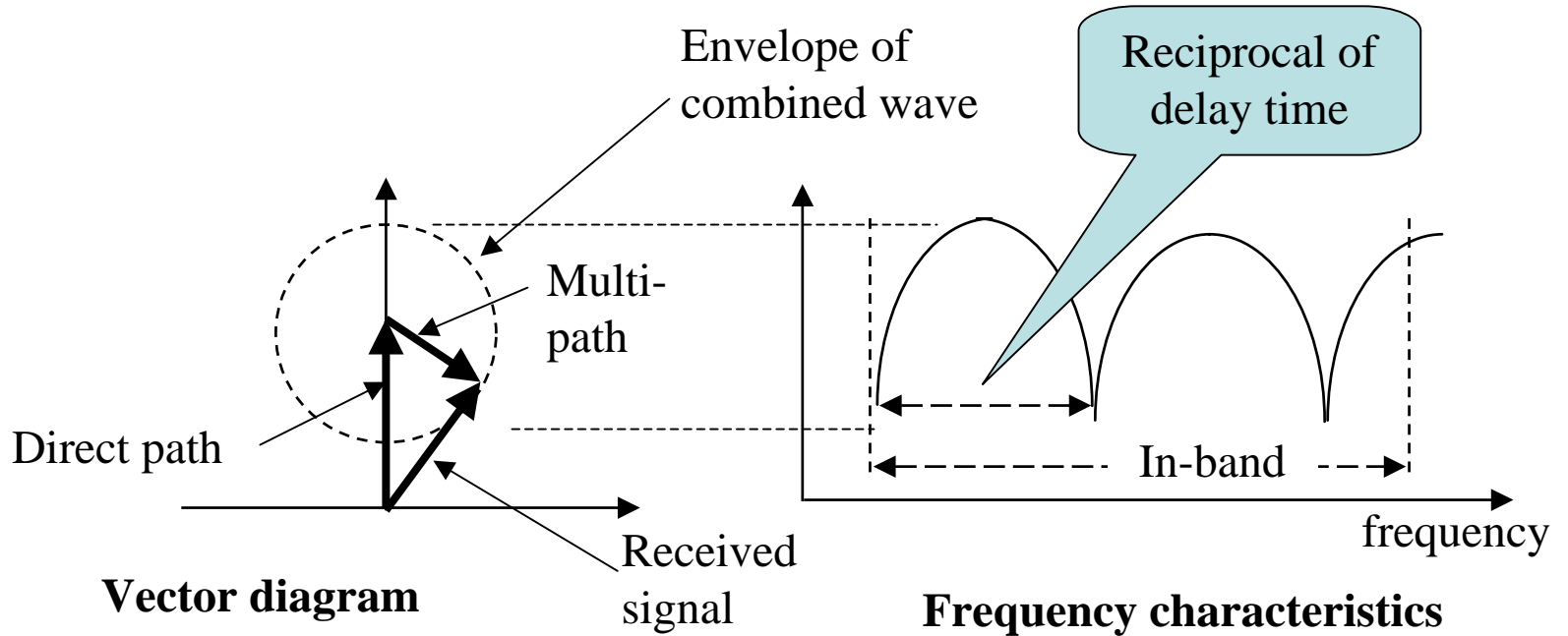
TV signal spectrum



OFDM frame structure (QPSK, 16QAM, 64QAM, mode 1)

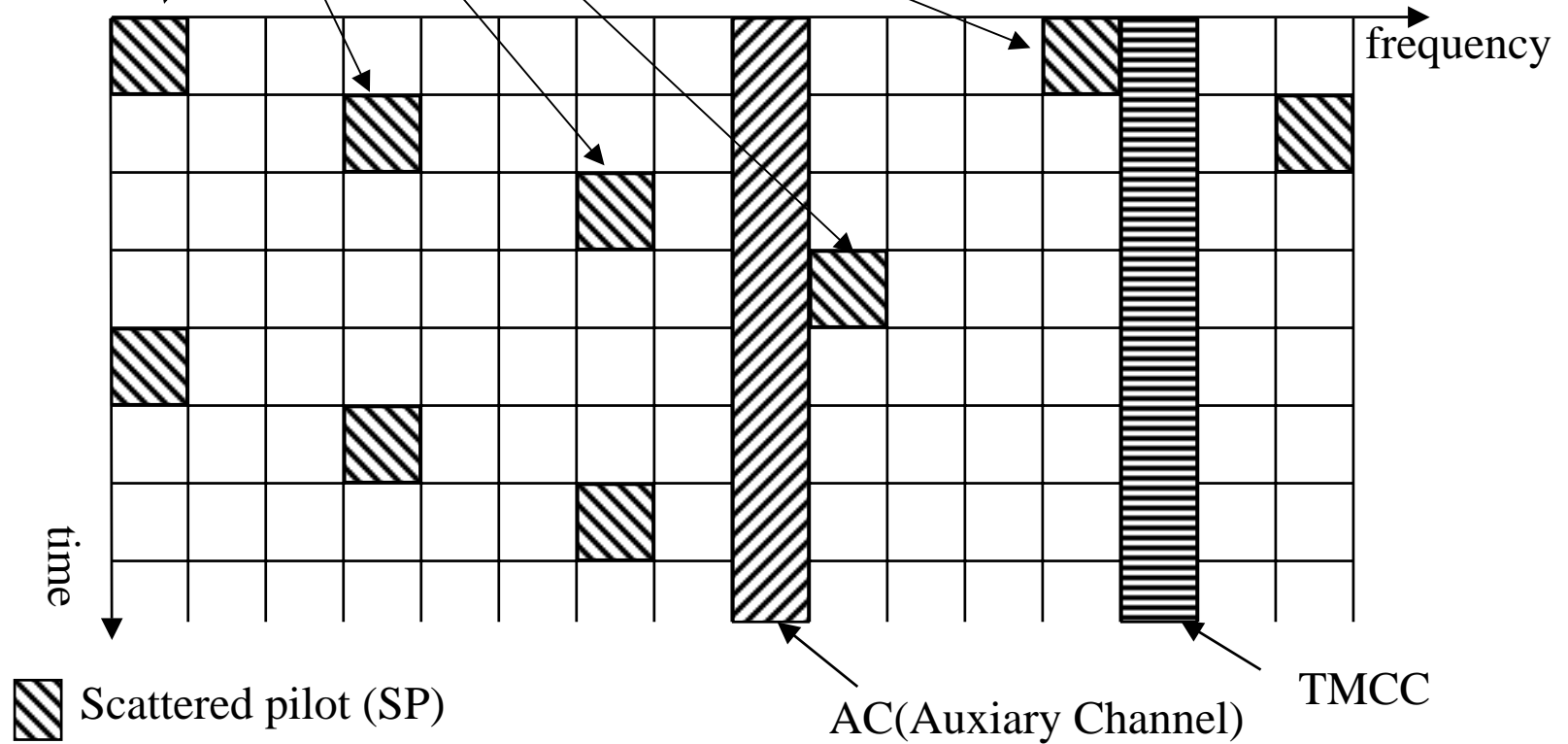
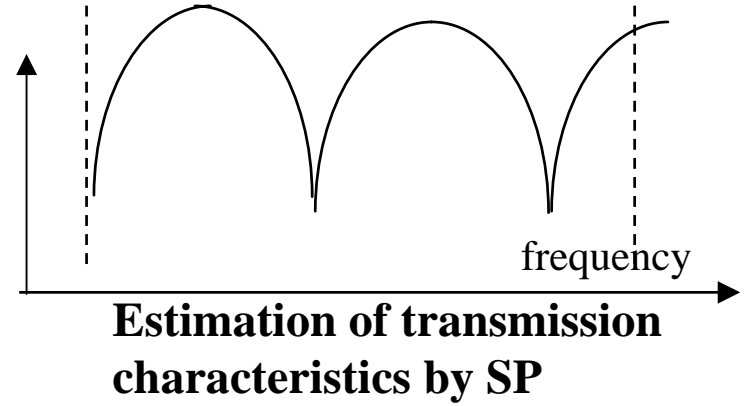


Frequency characteristics distortion caused by multi-path



Effect of scattered pilot (SP) signal

Scattered pilot (SP) is used to
Compensate the frequency distortion
caused by multi-path



Example of AC, TMCC (mode 1, QPSK, 16QAM, 64QAM)

(a) AC and TMCC Carrier Arrangements in Mode 1

Segment No.	11	9	7	5	3	1	0	2	4	6	8	10	12
AC1_1	10	53	61	11	20	74	35	76	4	40	8	7	98
AC1_2	28	83	100	101	40	100	79	97	89	89	64	89	101
TMCC 1	70	25	17	86	44	47	49	31	83	61	85	101	23

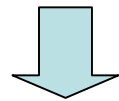
What is AC?

AC; (Auxiliary Channel)

AC is a channel designed to convey additional information on modulating signal-transmission control.

AC's additional information is transmitted by modulating the pilot carrier of a type similar to CP through DBPSK. The reference for differential modulation is provided at the first frame symbol, and takes the signal point that corresponds to the W_i value stipulated in Section 3.13.1.

- ➡ Details of AC is specified in ARIB STD-B31 reference
- ➡ Recently, new utilization of AC has been proposed, that is, the transmission network management information can be carried to relay station by using AC. Details will be explained in seminar #9



In DVB-T system, CP is inserted for carrier synchronization instead of AC, but CP cannot carry any information. This is the feature of AC

TMCC; transmission management and configuration control signal

The TMCC signal is used to convey information on how the receiver is to perform demodulation of information such as the hierarchical configuration and the OFDM-segment transmission parameters.

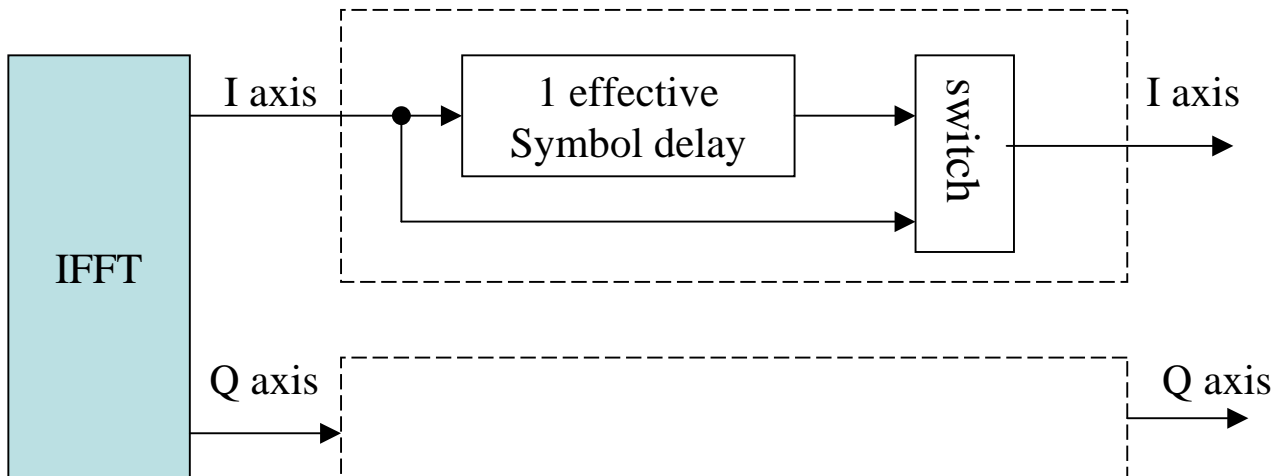
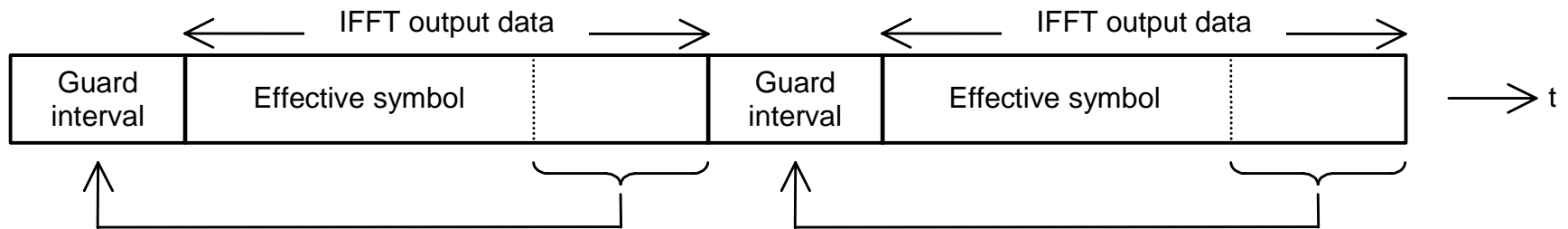
Table 3-20: Bit Assignment

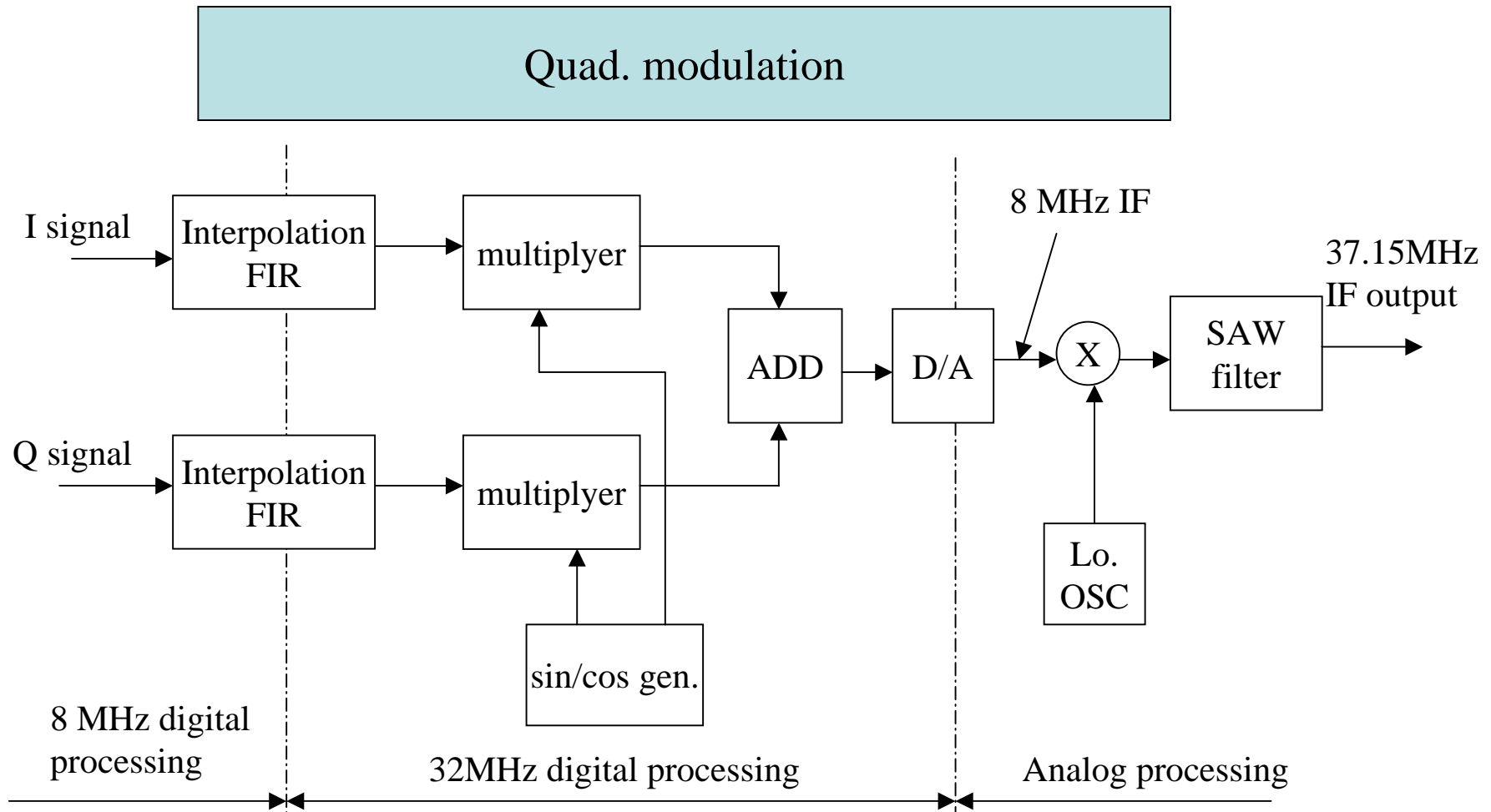
B_0	Reference for differential demodulation
$B_1 - B_{16}$	Synchronizing signal (w0 = 0011010111101110, w1 = 1100101000010001)
$B_{17} - B_{19}$	Segment type identification (differential: 111;synchronous: 000)
$B_{20} - B_{121}$	TMCC information (102 bits)
$B_{122} - B_{203}$	Parity bit

See details of TMCC information in 3.15.6 of ARIB STD-B31

Guard interval

A guard interval, the latter part of the IFFT (Inverse Fast Fourier Transform) data output for the specified duration, is added without any modification to the beginning of the effective symbol. This operation is shown in Fig. 3-33.





- (1) interpolation/FIR; convert from 8MHz sampling to 32 MHz sampling
- (2) Quad. Mod.; multiply I and Q data and add, 32 MHz digital signal process.
The output is 8MHz OFDM signal with 32MHz sampling
- (3) Analog circuit; up convert to 37.15 MHz IF and SAW filter.

5. ISDB-T_{SB} transmission system

1. Outline of ISDB-T_{SB} transmission system
2. Consecutive transmission system
3. Example of consecutive transmitter station

Relating clause of ARIB standard; B31 clause 3.12 – clause 3.15

1. ISDB-T_{SB} transmission system

(1) What is ISDB-T_{SB}

ISDB-TSB transmission system is unique in ISDB-T family. This transmission system has been standardized for narrow band ISDB-T transmission system, which is focused to audio and data service, therefore, called ISDB-TSB.

(2) Commonality with ISDB-T

(a) Same segment transmission construction. But ,considering narrow band reception, only 1 segment and 3 segment transmission systems are standardized

(b) Adopt same transmission parameters as ISDB-T.

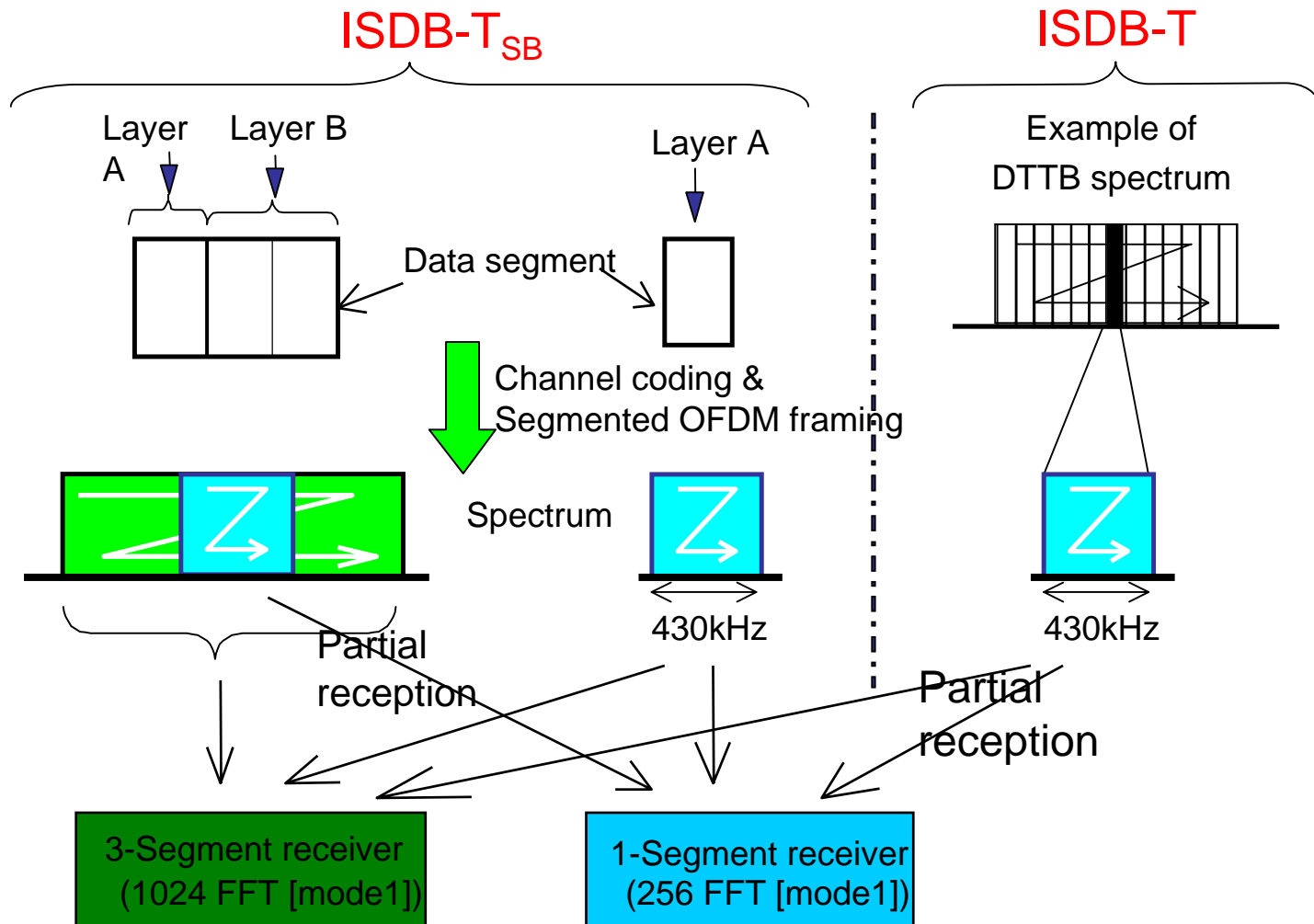
(c) Commonality of 1 segment receiver with ISDB-T partial reception

(3) Efficient use of frequency resource

(a) Consecutive transmission system. This system is unique for ISDB-TSB, this transmission system is to transmit plural channel without guard band

(b) To achieve consecutive transmission, phase compensation technology at transmitter side is adopted

ISDB-T_{SB} transmission and partial reception



Transmission parameters

Mode	1	2	3
Segment(s)	1 or 3		
Bandwidth	430kHz or 1.3MHz		
Carrier spacing	3.97kHz	1.98kHz	0.99kHz
Total carriers	109 / 325	217 / 649	433 / 1297
Data carriers	96 / 288	192 / 576	384 / 1152
TMCC,AC,CP, SP carriers	13 / 37	25 / 73	49 / 145
Modulation	QPSK, 16QAM, 64QAM, DQPSK		

Transmission parameters (continued)

Mode	1	2	3
Symbol duration	252 μ s	504 μ s	1.008ms
Guard interval	1/4 \sim 1/32 of symbol duration		
Symbols/frame	204		
Frame duration	53 \sim 64ms	106 \sim 129ms	212 \sim 257ms
Inner code	Convolutional code (1/2, 2/3, 3/4, 5/6, 7/8)		
Outer code	(204,188) RS code		
Interleaving	Time and Frequency		

Example of information bit-rate(TS rate)

	1segment	3segment	note
DQPSK, $r=1/2$, $T_g=1/4$	280kbps	0.84Mbps	Min. rate
DQPSK, $r=1/2$, $T_g=1/16$	330kbps	0.99Mbps	for mobile
DQPSK, $r=2/3$, $T_g=1/16$	440kbps	1.32Mbps	for mobile
16QAM, $r=1/2$, $T_g=1/16$	660kbps	1.98Mbps	for mobile
64QAM, $r=7/8$, $T_g=1/32$	1.87Mbps	5.20Mbps	Max. rate
Bandwidth	430kbps	1.3Mbps	

The information bit rates do not depend on transmission mode 1, 2 or 3, They depend on modulation ,coding rate and guard interval

Spectrum utilization (1)

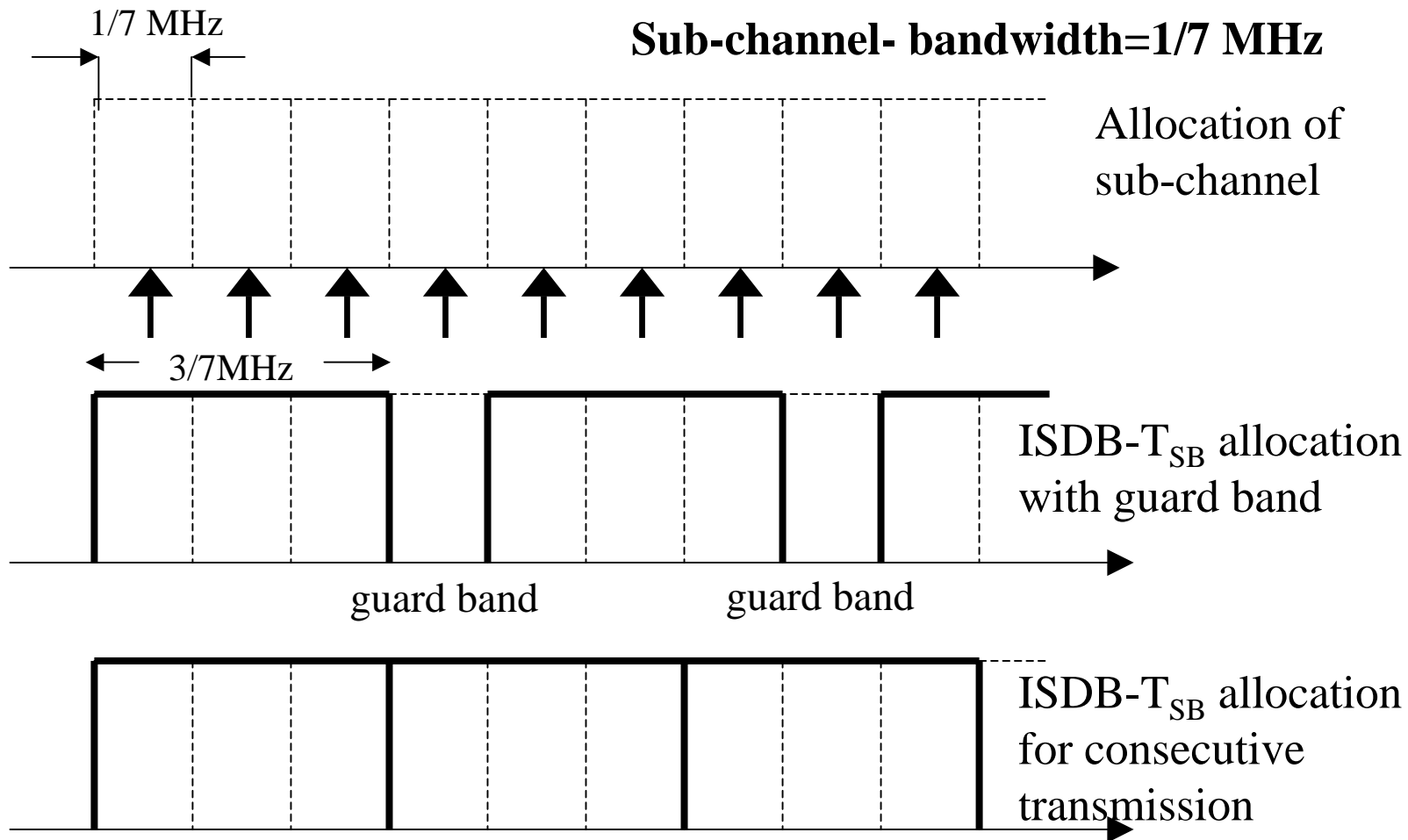
Broadcasting frequency bands are looked upon as a sequence of segments, which have a bandwidth of one fourteenth of a TV channel.

BST-OFDM scheme provides followings.

- DTV uses 13 segments, remaining one ; guard band,
- DSB uses 1 or 3 segments
- 1-segment reception of 13 segment-TV signal by DSB receiver
- Consecutive-segment transmission without guard bands
- systematic frequency re-packing towards total digital age

Frequency allocation of consecutive transmission

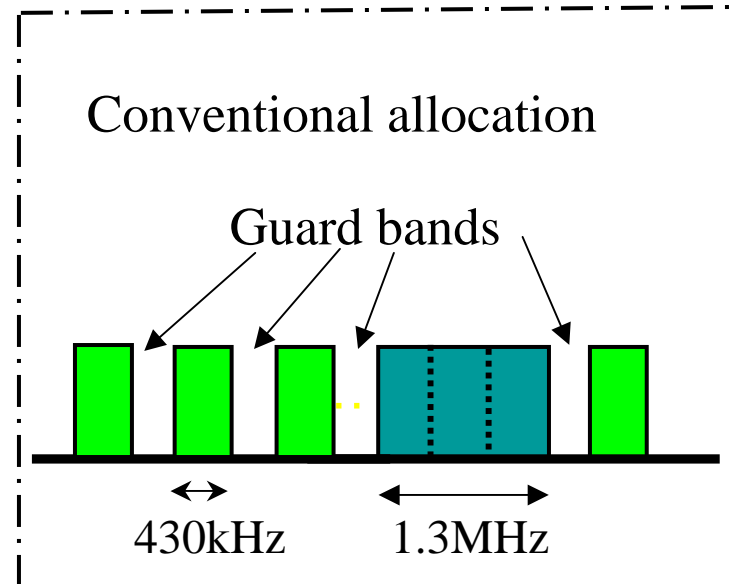
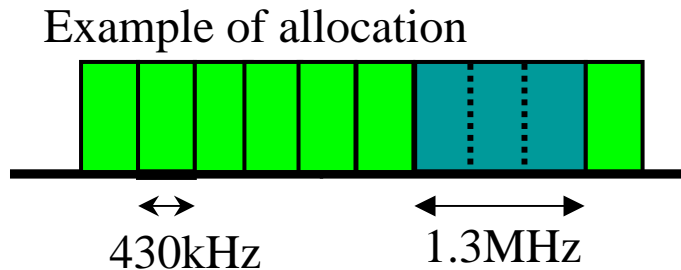
Concept of sub-channel



Spectrum utilization (2)

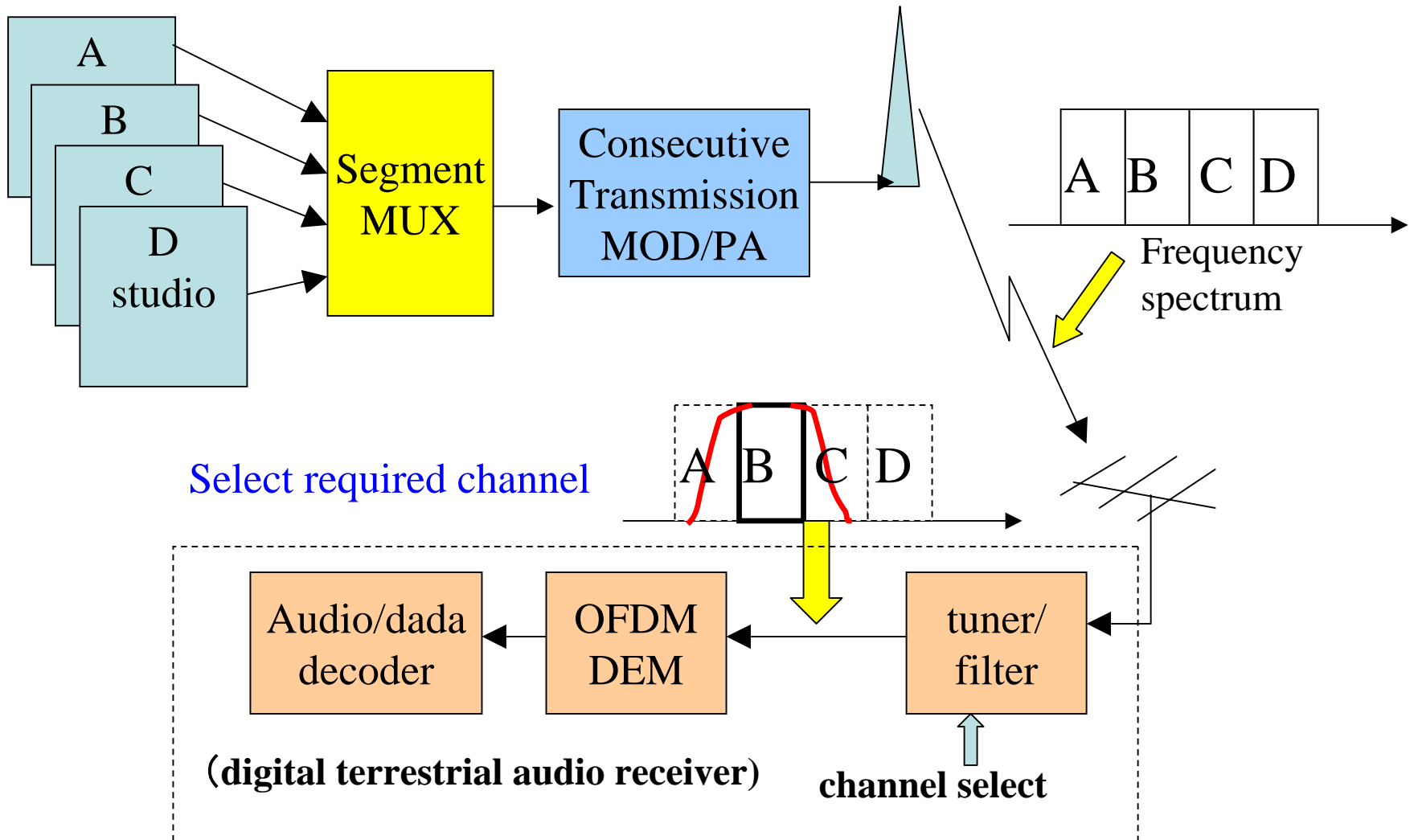
Consecutive-segment Transmission of DSB channels

Transmission from single transmitter
keeping OFDM -condition



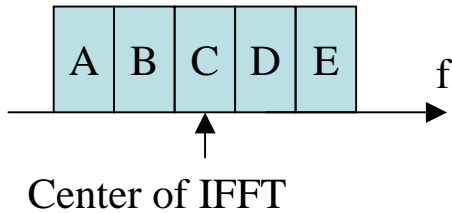
Frequency utilization efficiency will be improved up to 150%.

Image of consecutive transmission and reception



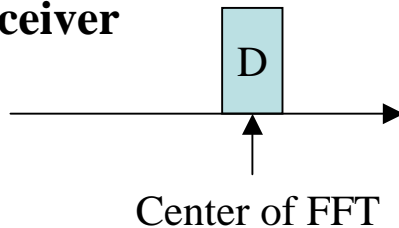
Why is the phase compensation of segment necessary for consecutive transmission ?

transmitter



← Frequency allocation for 5 one segment channel consecutive transmission

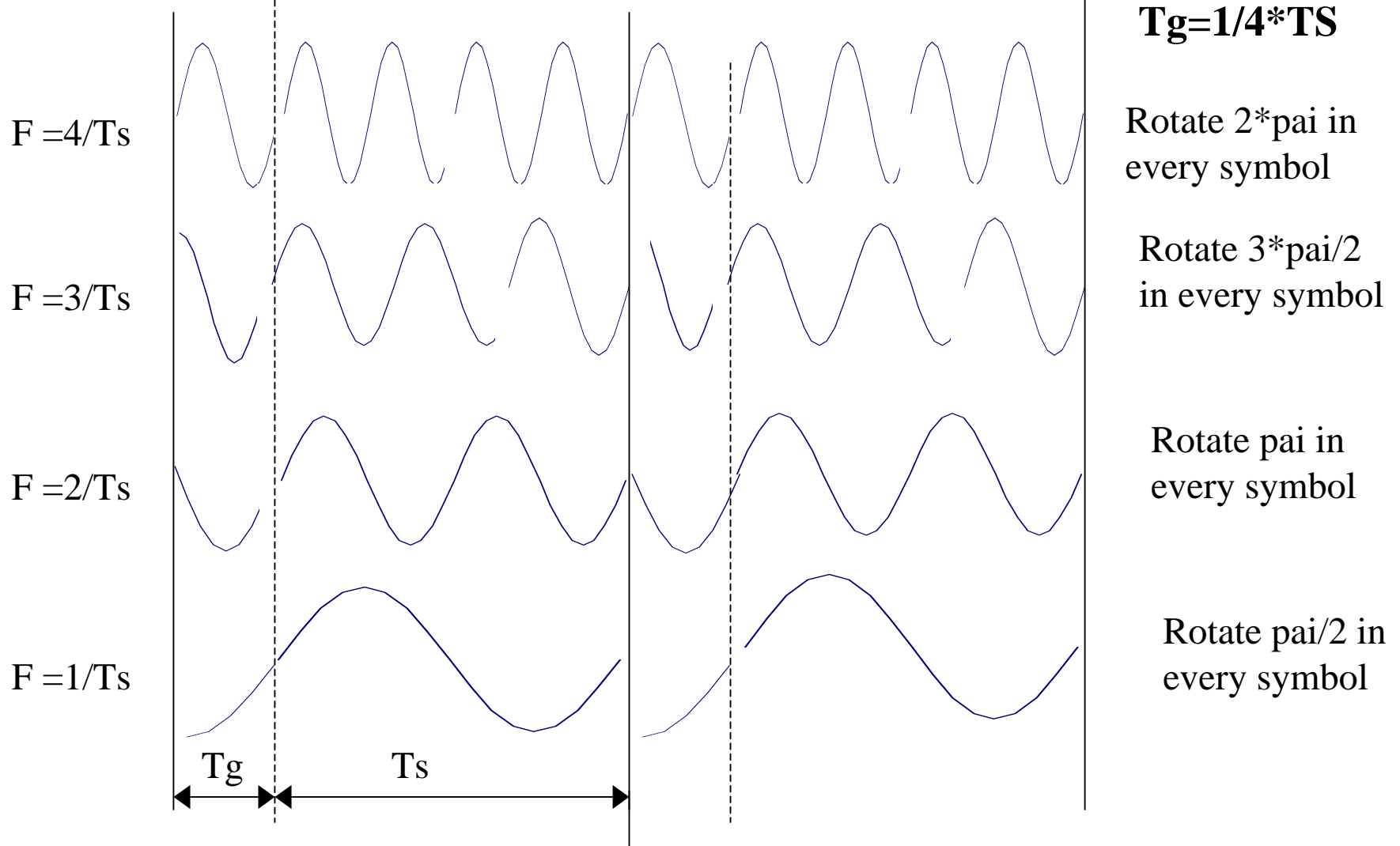
receiver



← Select channel D at receiver side

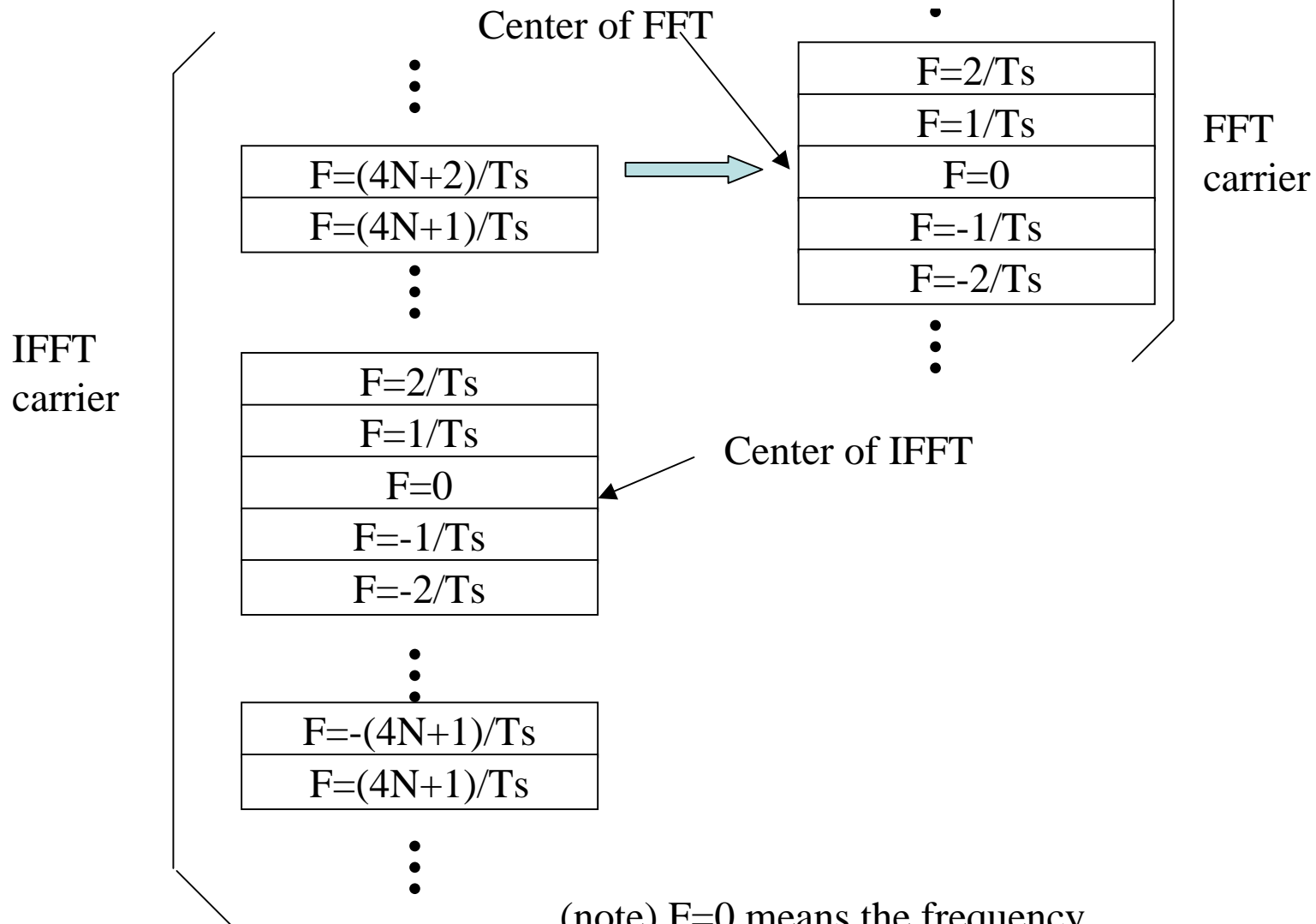
The center of IFFT and FFT is different , as a result, each carrier of received OFDM signal rotate during Guard interval period. (see next page)
This phase rotation is compensated at the transmitter side.

Phase rotation in every symbol



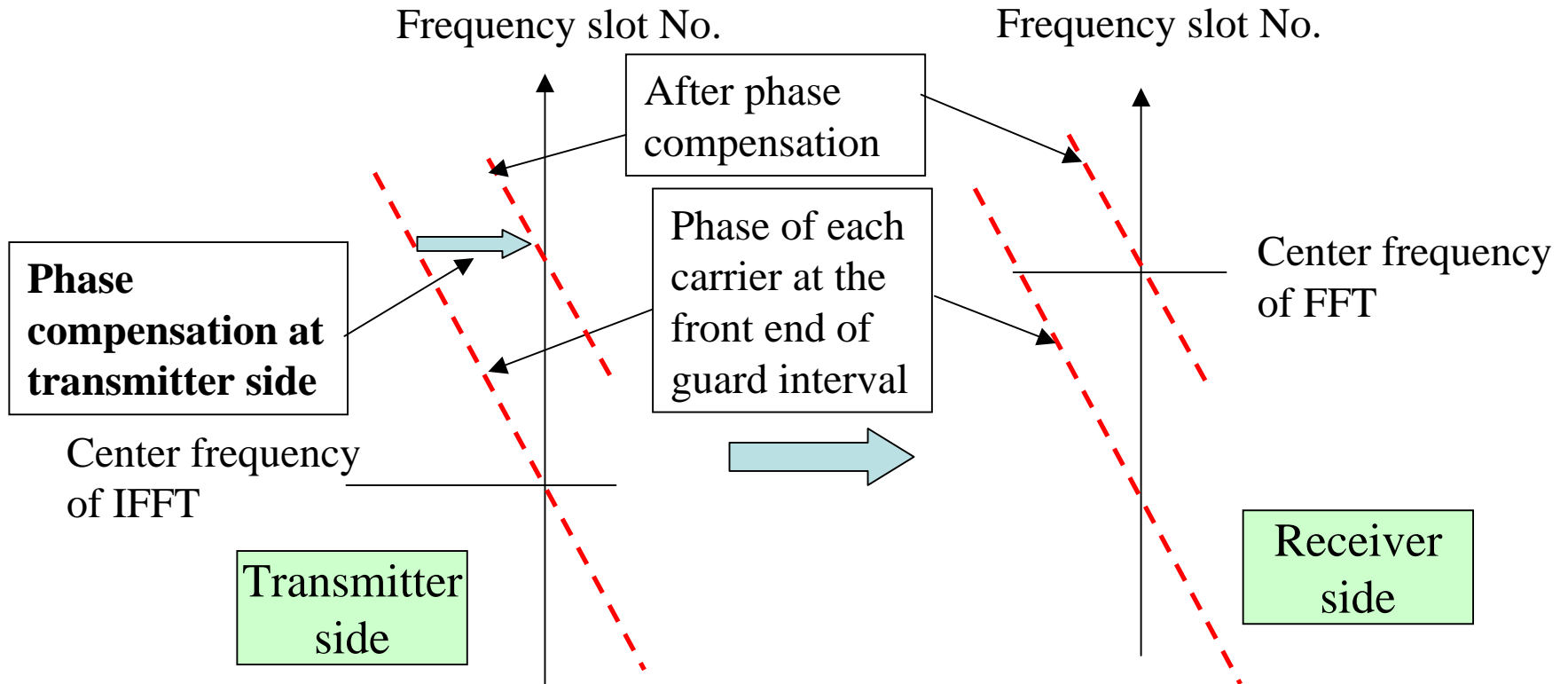
During guard interval (T_g) period, phase rotation ($=2 \cdot N \cdot \text{pai} \cdot T_g/T_s$) occurs. Consequently, each carrier seems to rotate in every symbol period.

Relationship between IFFT and FFT for consecutive transmission



(note) $F=0$ means the frequency which is the center of FFT and IFFT

Phase of Each carrier in consecutive transmission

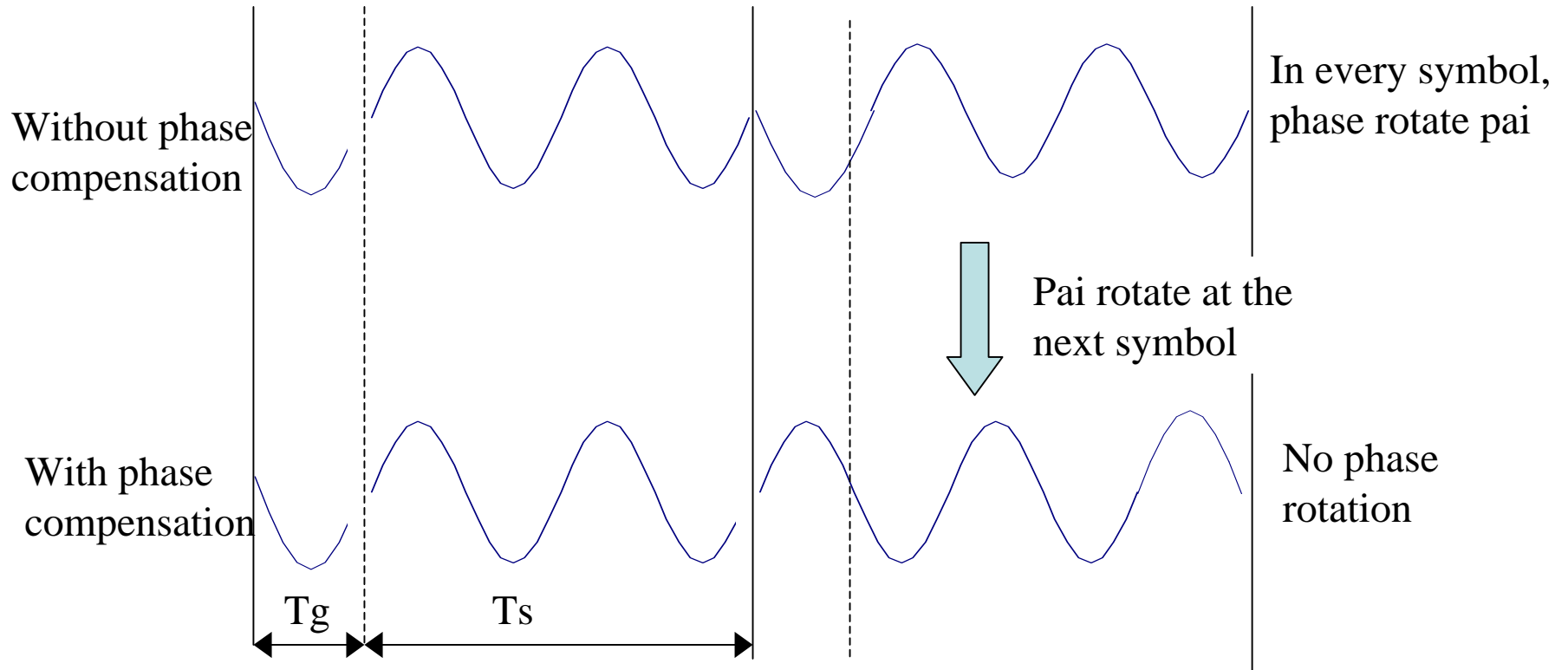


In case of consecutive transmission, center frequency of IFFT and FFT is different. Therefore, during guard interval, each carrier phase rotate according to above figure. To avoid such phase rotation at receiver FFT, phase compensation is done at transmitter side.

Example of phase compensation

$$F = (4N+2)/T_s$$

$$T_g = (1/4) * T_s$$



In this example, center frequency of FFT is equal to $F=(4N+2)/T_s$ of IFFT. Therefore, if T_g is equal to $(1/4)*T_s$, at the front end of every symbol rotate π .

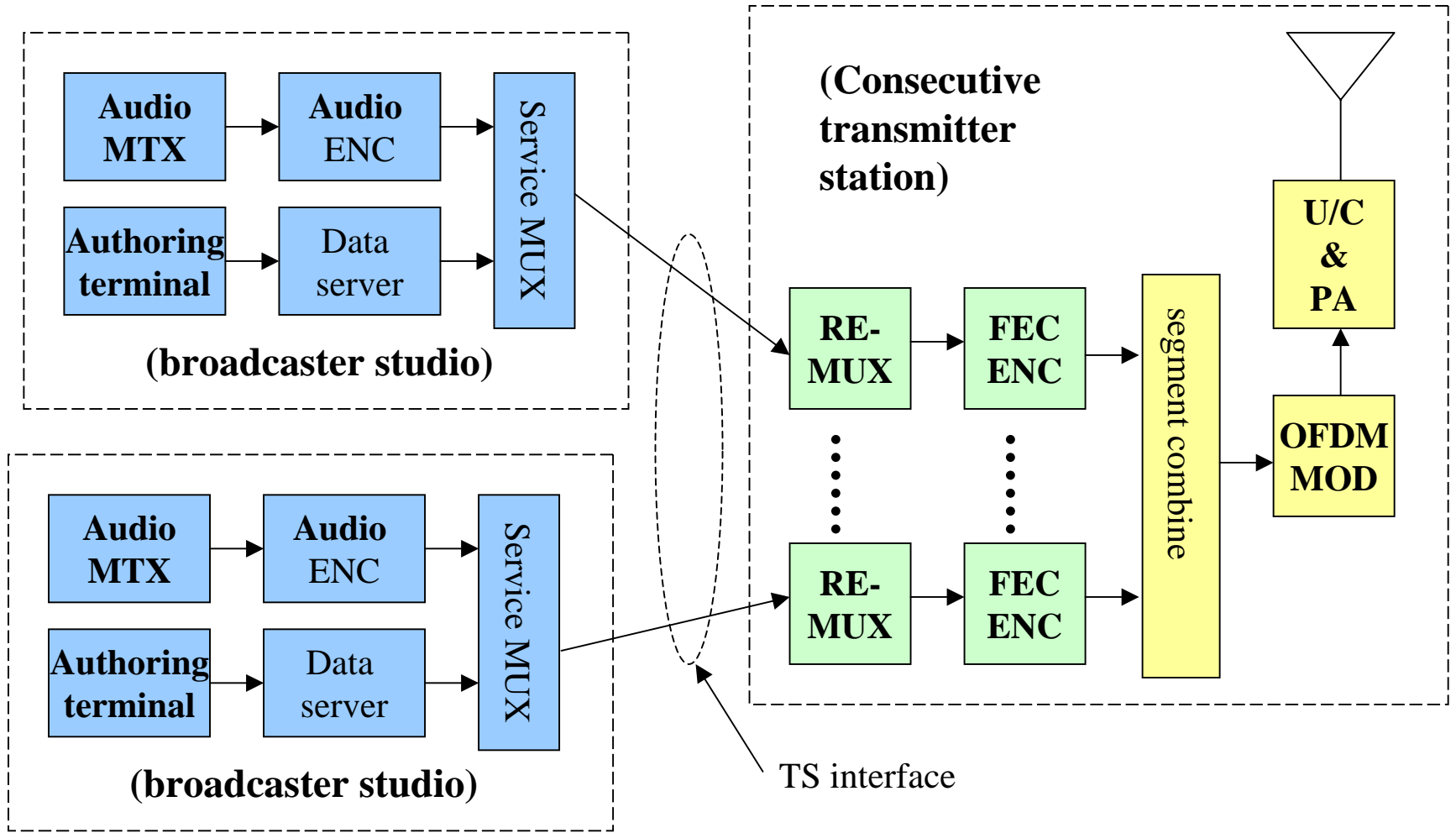
Phase compensation in every symbol

Upper adjacent channel format

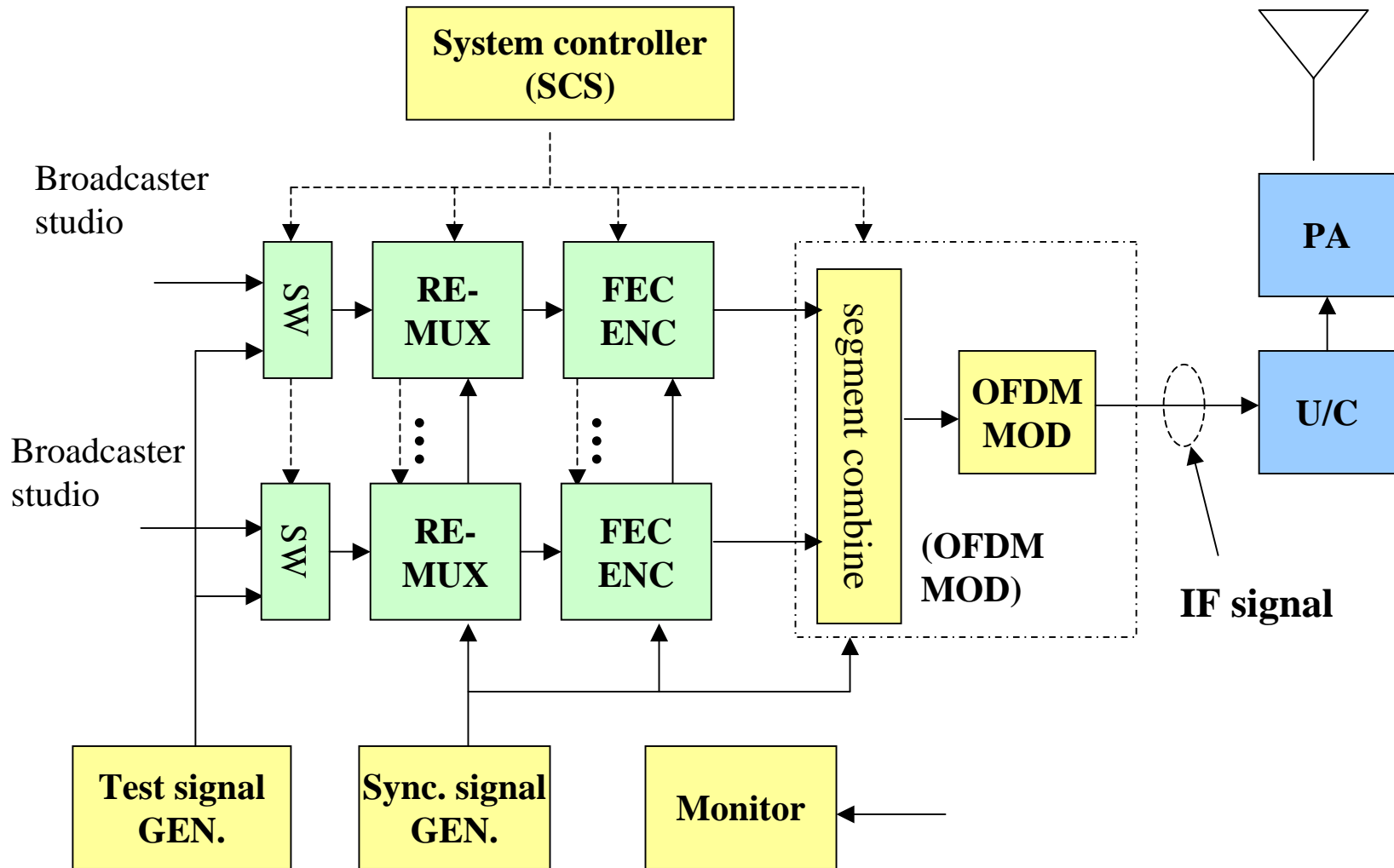
GI		1 segment			3 segment		
		mode 1	mode 2	mode 3	mode 1	mode 2	mode 3
1	1/32	-3/8	-3/4	-1/2	-6/8	-2/4	0
	1/16	-3/4	-1/2	0	-2/4	0	0
	1/8	-1/2	0	0	0	0	0
	1/4	0	0	0	0	0	0
3	1/32	-6/8	-2/4	0	-1/8	-1/4	-1/2
	1/16	-2/4	0	0	-1/4	-1/2	0
	1/8	0	0	0	-1/2	0	0
	1/4	0	0	0	0	0	0

Number of segment pf received channel

ISDB-TSB studio & transmitter system for consecutive transmission system



Details of ISDB-T_{SB} transmitter block diagram



After RE-MUX , frame and clock of each channel are synchronized

Details of ISDB-TSB transmitter station is explained in next seminar

Seminar #4

END

Obiligardo !