

Channel coding for ISDB-T3

23rd September 2026

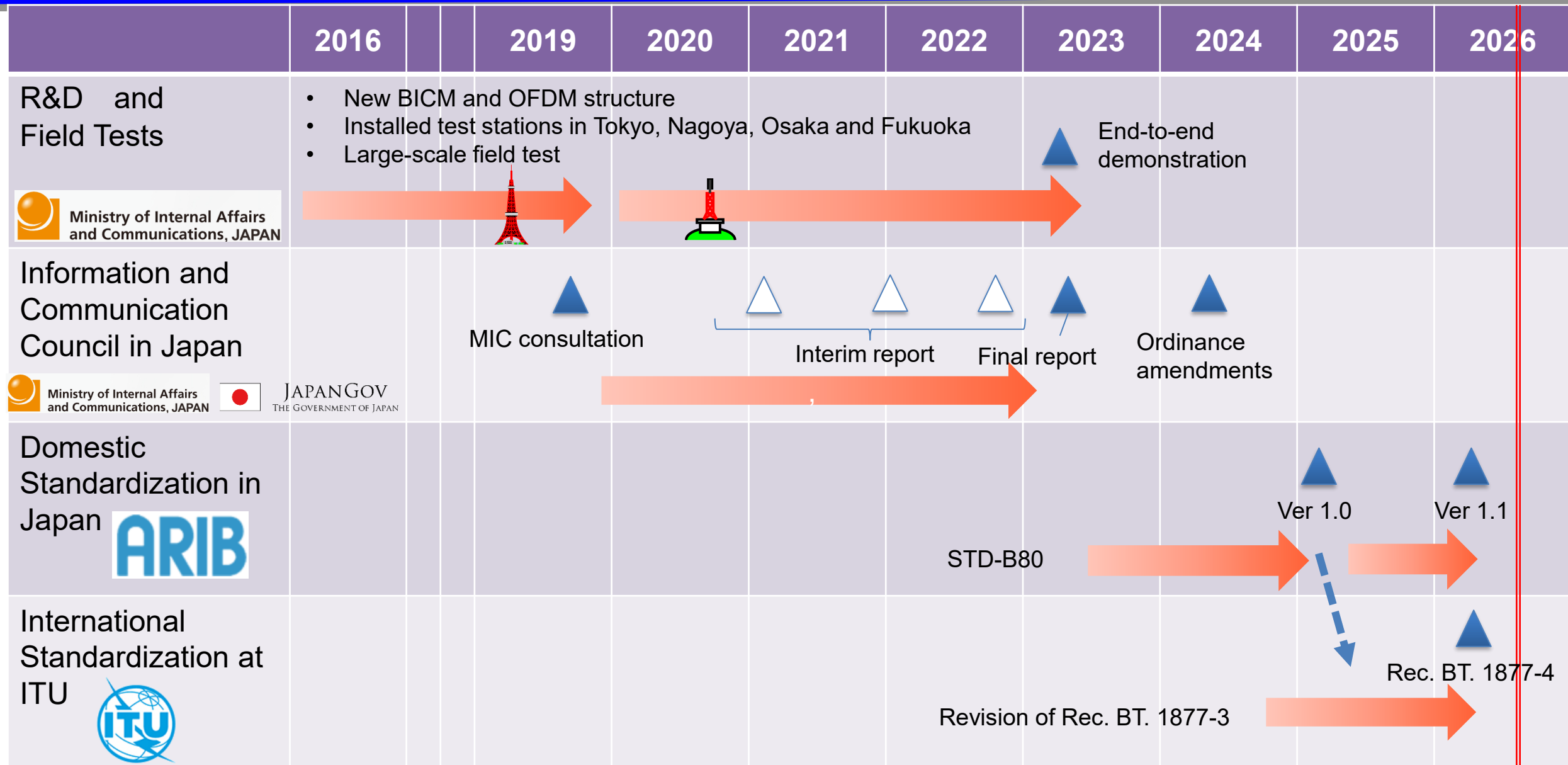
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Chair, Broadcasting International Standardization Sub-Working Group-A, ARIB
Shingo ASAKURA

Agenda

1. Introduction and overview
2. Transmission frame
3. Transmission control signal
4. Subframe
 - a. Bit-Interleaved Coded Modulation
 - b. OFDM modulation
5. Extended duration
6. Optional features
7. Conclusion

R&D and standardization

Now



Overview of ISDB-T3

- Inherits the ISDB-T system (System C of 1st generation DTTB [1])
 - Band-segmented OFDM
 - Partial reception capability
 - Emergency Warning Broadcasting System (EWBS)
- Enhanced spectrum efficiency through
 - Low-Density Parity-Check (LDPC) code
 - Non-Uniform Constellation (NUC)
- Native support for MMT^[2] and IP-based input streams

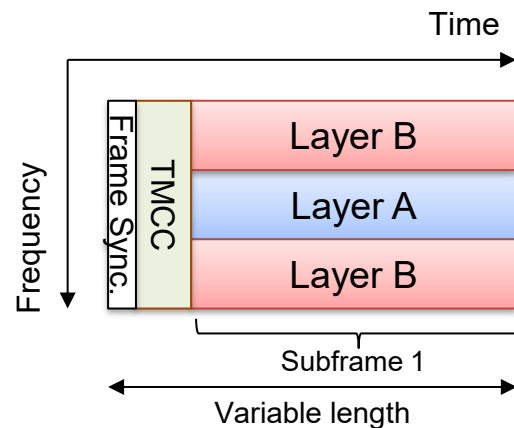
[1] Recommendation ITU-R BT.1306-8

[2] Mpeg Media Transport, Recommendation ITU-R BT.2074-2

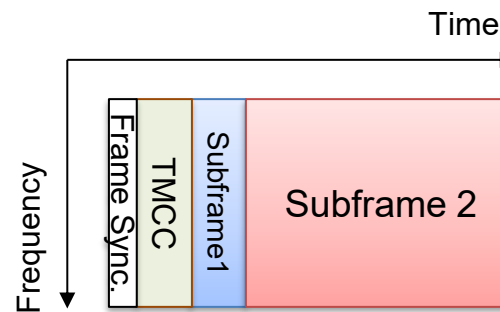
Transmission frame

- Flexible multiplexing scheme
 - ✓ TMCC supports variable subframe length
 - ✓ Extended duration remains available after ISDB-T3 introduction
- Fine throughput control per layer
 - ✓ Configurable frame lengths
 - ✓ Configurable subframe lengths for each layer

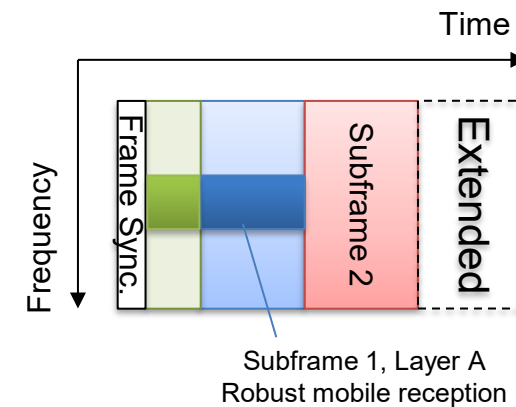
TMCC: Transmission and Multiplexing Configuration Control



FDM

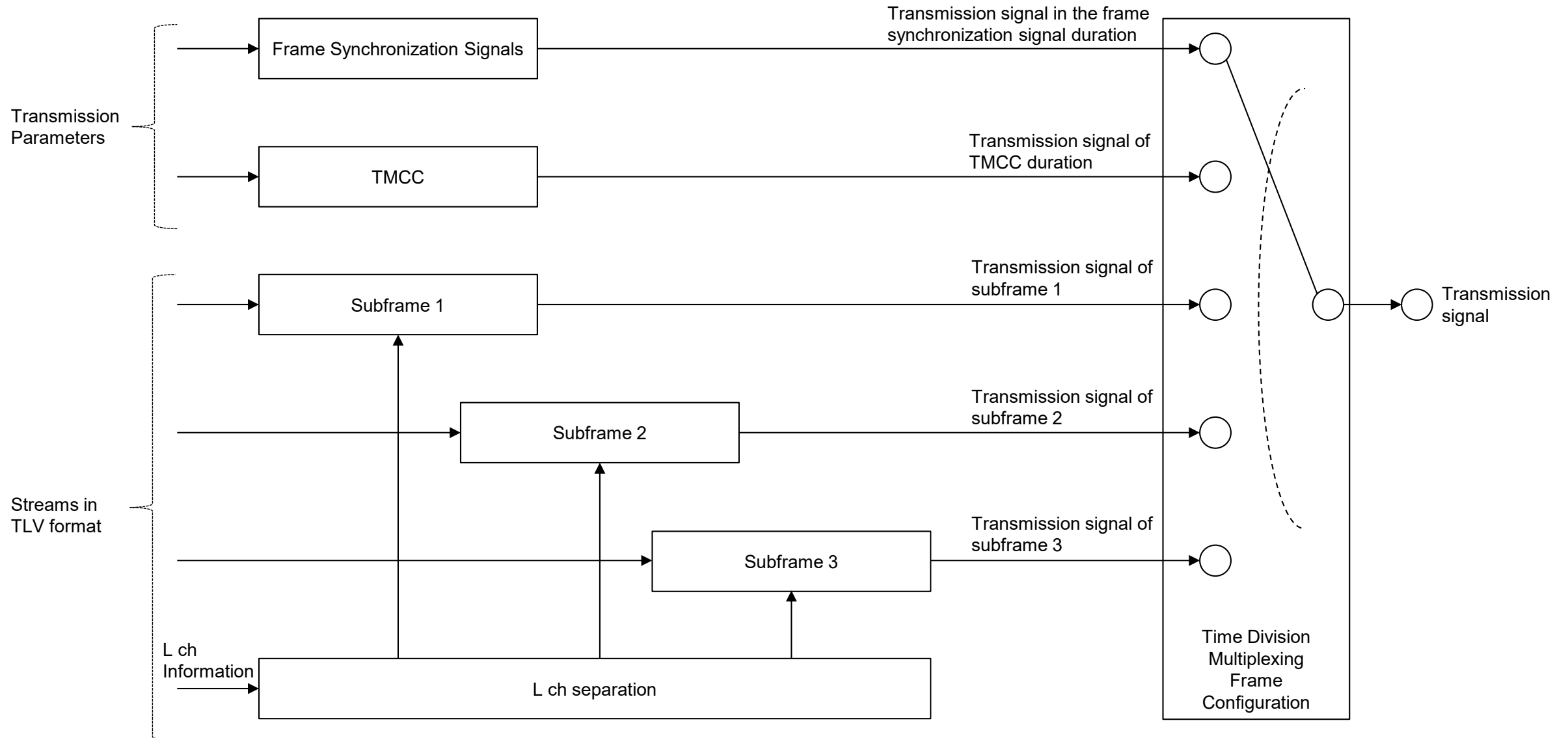


TDM



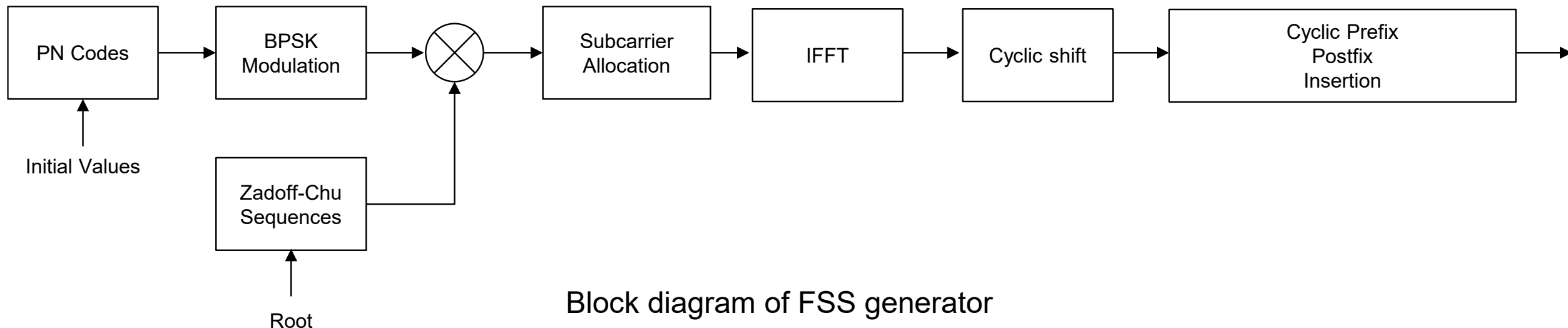
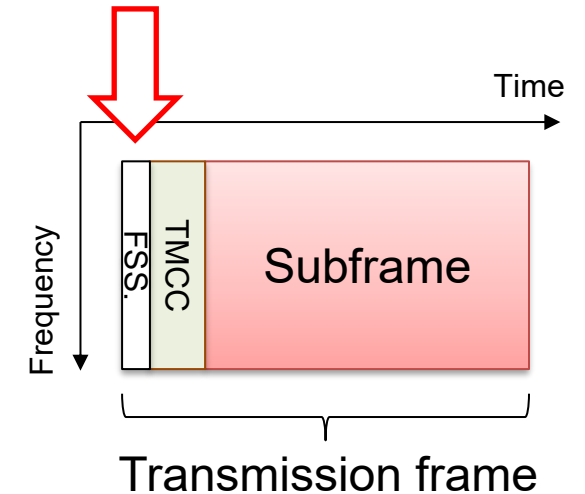
FDM & TDM

Transmission frame configuration



Frame Synchronization Signal (FSS)

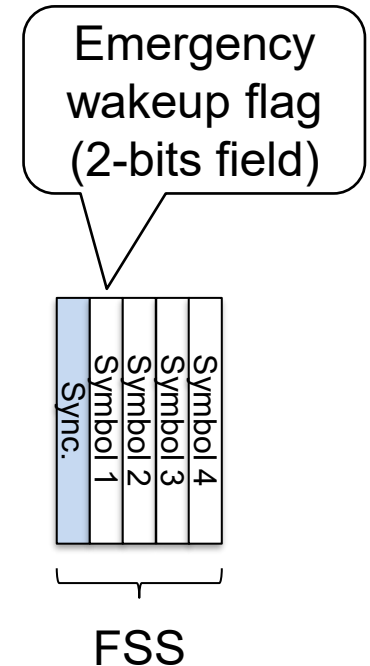
- Positioned at the start of every transmission frame
- Transmits essential signaling information:
 - Emergency wake-up flag
 - Partial Reception (PR) flag
 - TMCC signal parameters



FSS

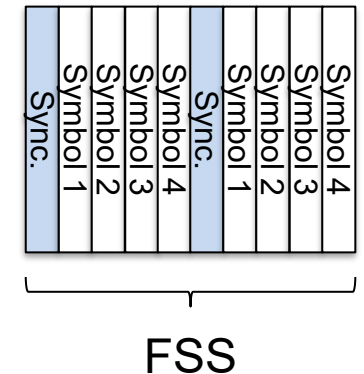
Without partial reception band

- 5 OFDM symbols
 - 1 synchronous symbols and 4 data symbols
 - 8 bits transmitted per OFDM symbol



With partial reception band

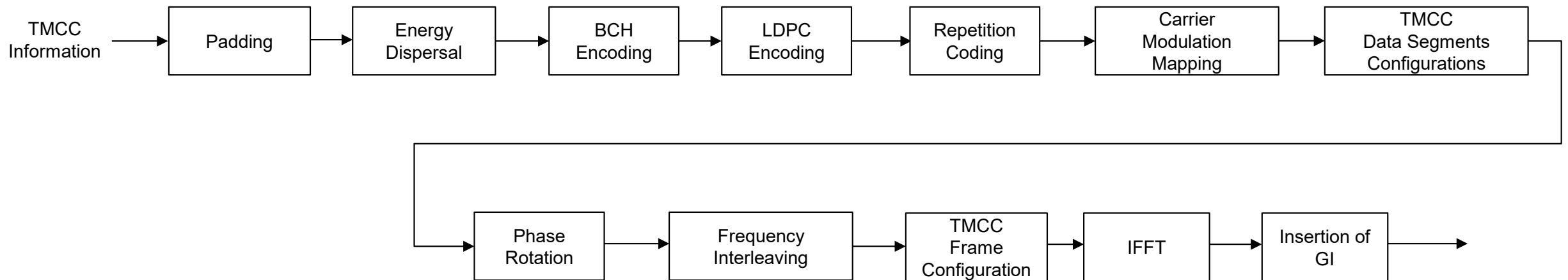
- 10 OFDM symbols
 - Repetition of the 5 OFDM symbols.
 - Sufficient frame synchronization performance for narrow band receivers



TMCC signal

(Transmission and Multiplexing Configuration Control)

- Carries control information for all subframes
- TMCC parameters are transmitted via the FSS
- Offers enough capacity to support flexible schemes



Block diagram of TMCC signal generator

TMCC

- OFDM parameters

FFT size N_{FFT} (mode)	8192(3), 16384(4), 32768(5)
GI duration ratio	1/4, 1/8, 1/16, 1/32, 1/64, 1/256, $800/N_{\text{FFT}}$, $1600/N_{\text{FFT}}$
Pilot	Only Continual Pilot (CP) is available
LDPC code	(1224, 252), (2448, 252)
Carrier modulation	BPSK, QPSK

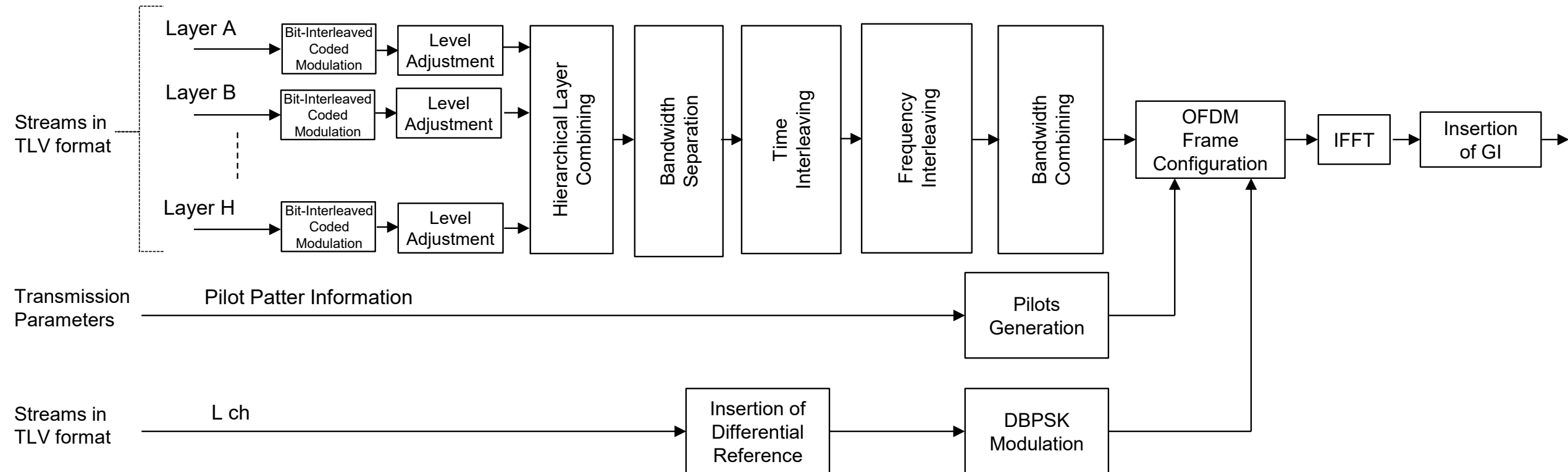
N_{FFT} :FFT size

- TMCC Information

TMCC size, update count, countdown index, NTP timestamp, **Emergency Warning Broadcast System (EWBS) flag**, Earthquake Early Warning (EEW) data, frame configuration, subframe configuration, layer configuration, sublayer configuration, auxiliary data (Extended frame configuration, channel bonding configuration, Lch configuration)

Subframe configuration

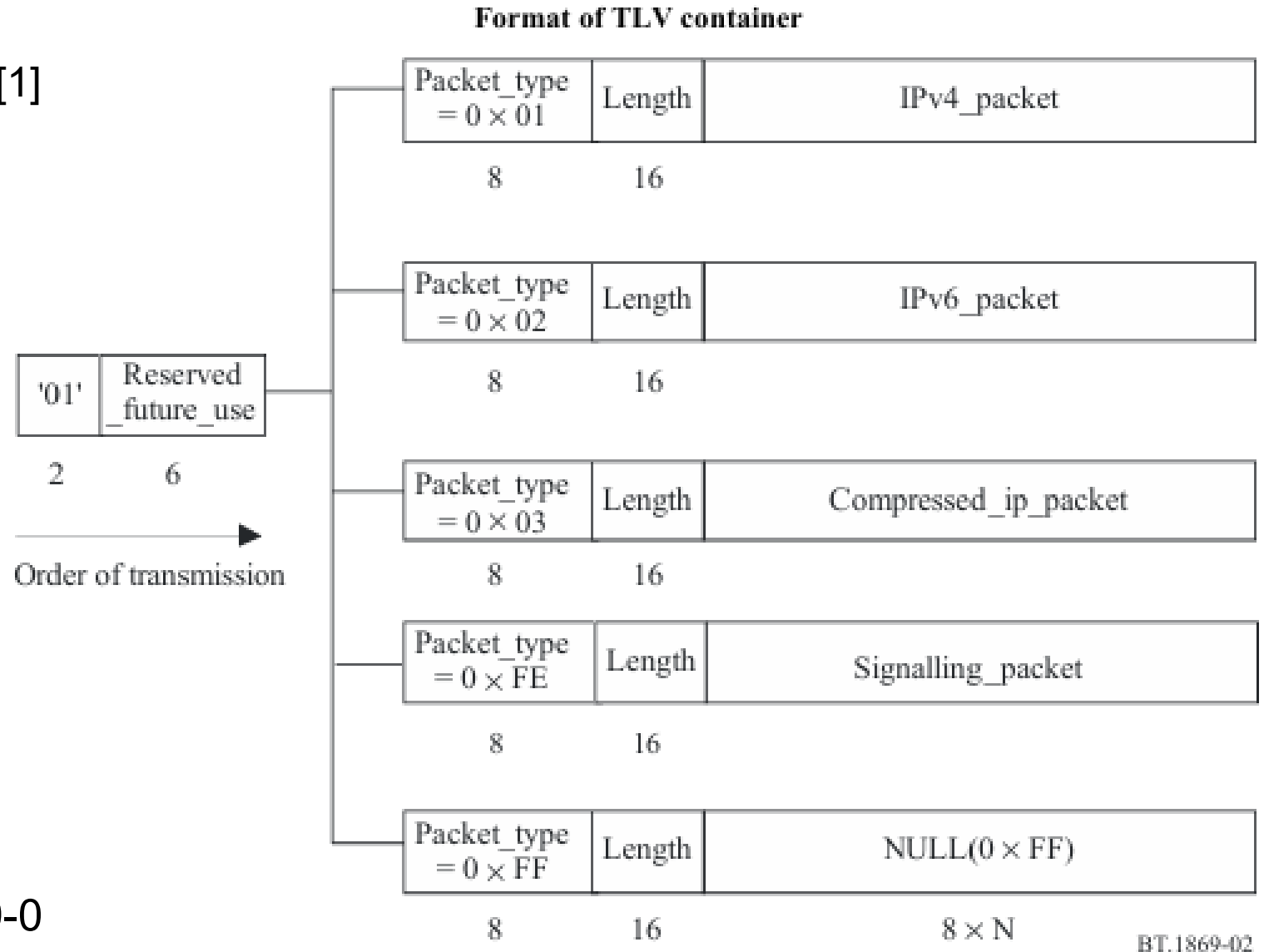
- Up to 8 layers can be multiplexed in one channel
- Independent configuration of transmission parameters for each layer
- Auxiliary channel designated as “L channel (L ch)”



Block diagram of subframe generator

Input format

Type-Length-Value (TLV) [1]

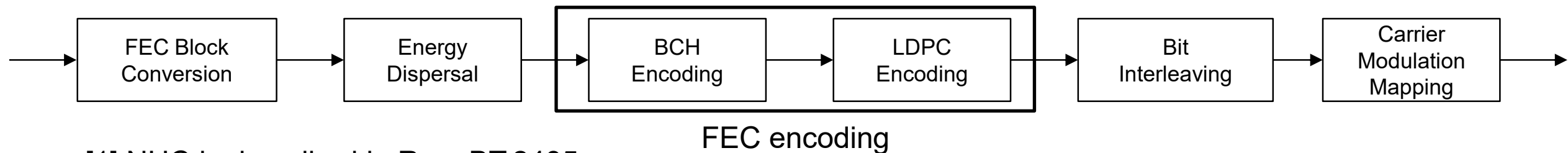


[1] Recommendation ITU-R BT.1869-0

BT.1869-02

Bit-Interleaved Coded Modulation (BICM)

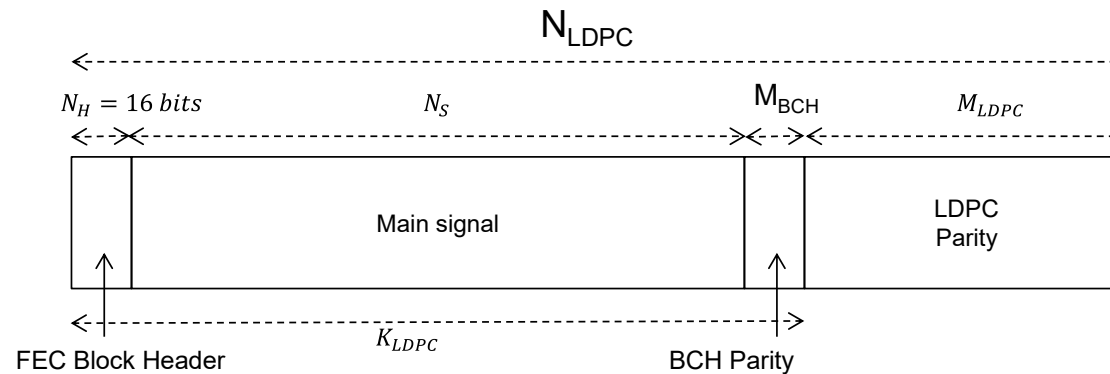
- TLV packets converted into FEC blocks
- Bit interleaving performed after FEC encoding
- Carrier modulation mapping applied to interleaved bits
 - QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM
 - Uniform Constellation (UC) or Non-Uniform Constellation (NUC)^[1]



[1] NUC is described in Rep. BT.2485

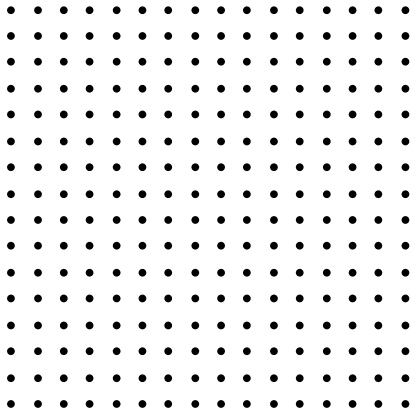
Forward error correction

- Inner code: LDPC
 - Code lengths: 69,120 (Normal) or 17,280 (Short)
 - Code rates: 2/16 to 14/16
 - Parity check matrix^[1]: IRA or MET
- Outer code: BCH
 - Polynomials: 16th (Normal) or 14th (Short)
 - Correction bits: 12

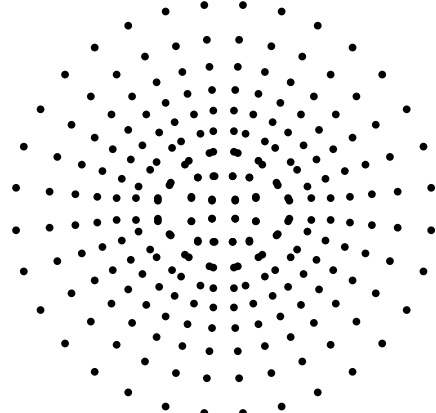


[1] Parity check matrix is described in Rep. BT.2485

Constellation

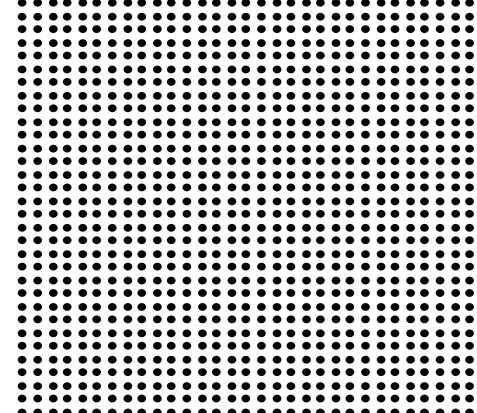


UC

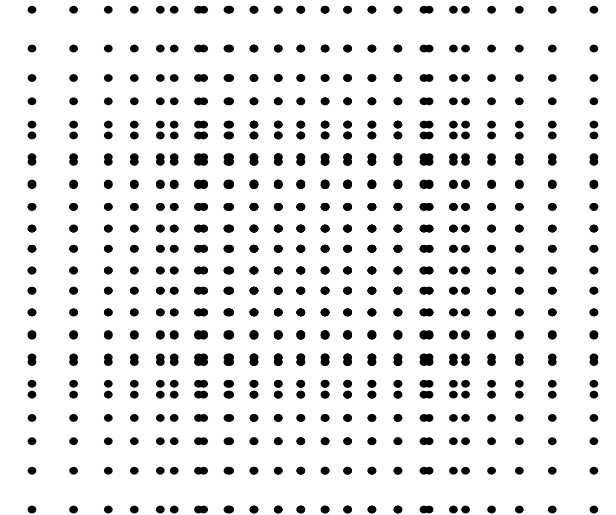


2-Dimensional NUC

256QAM



UC



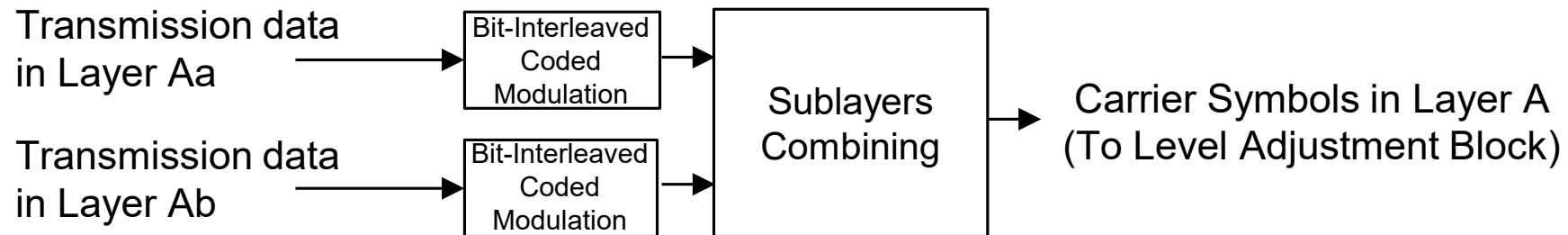
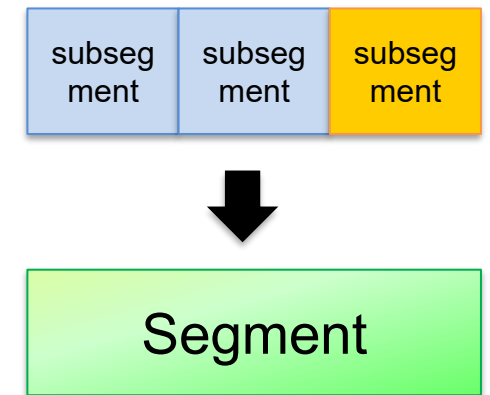
1-Dimensional NUC

1024QAM

NUC is described in Rep. BT.2485

Sublayers

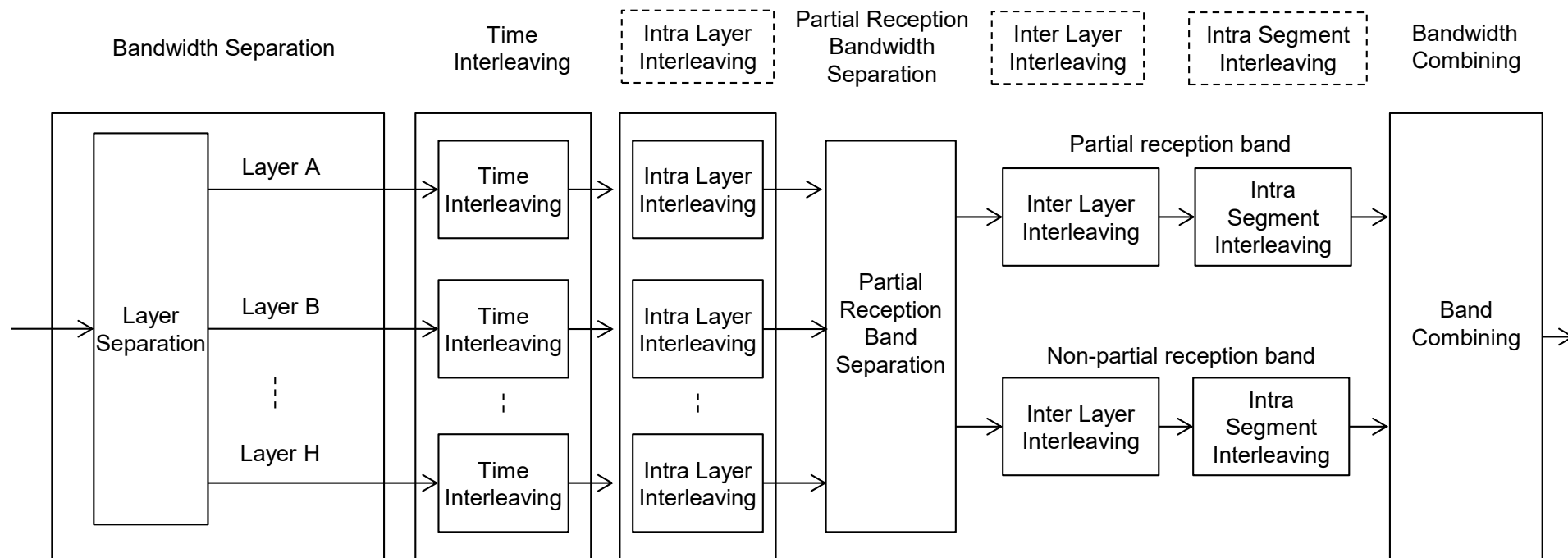
- Up to two sublayers per layer
- Sublayer unit: 1/3 segment (subsegment)
- Independent BICM configuration for each sublayer



Conversion from the sublayers into the layer

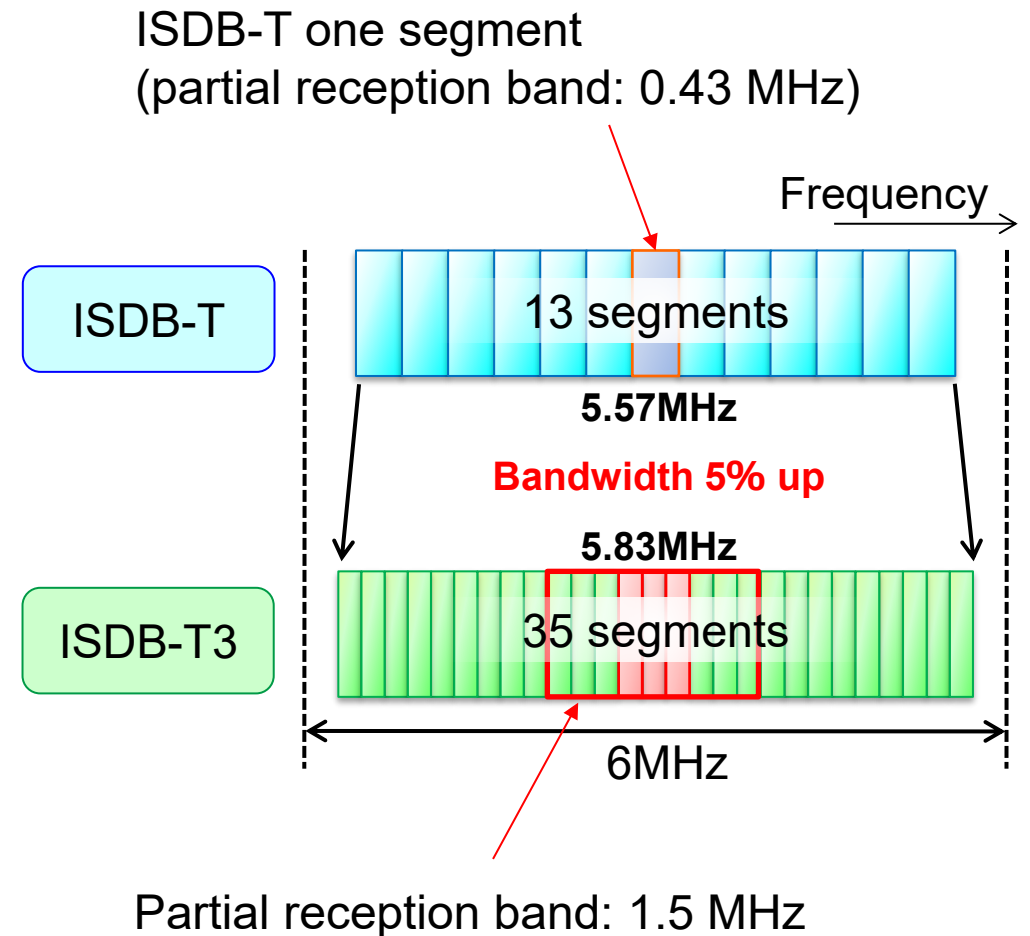
Time and Frequency interleaving

- Time interleaving
 - Convolutional interleaving for each layer
 - Configurable depths: 0, 0.25, 0.5, 0.75, 1, 1.5, 2, 3 frames
- Frequency interleaving
 - Independently applied in partial reception band and non-partial reception band



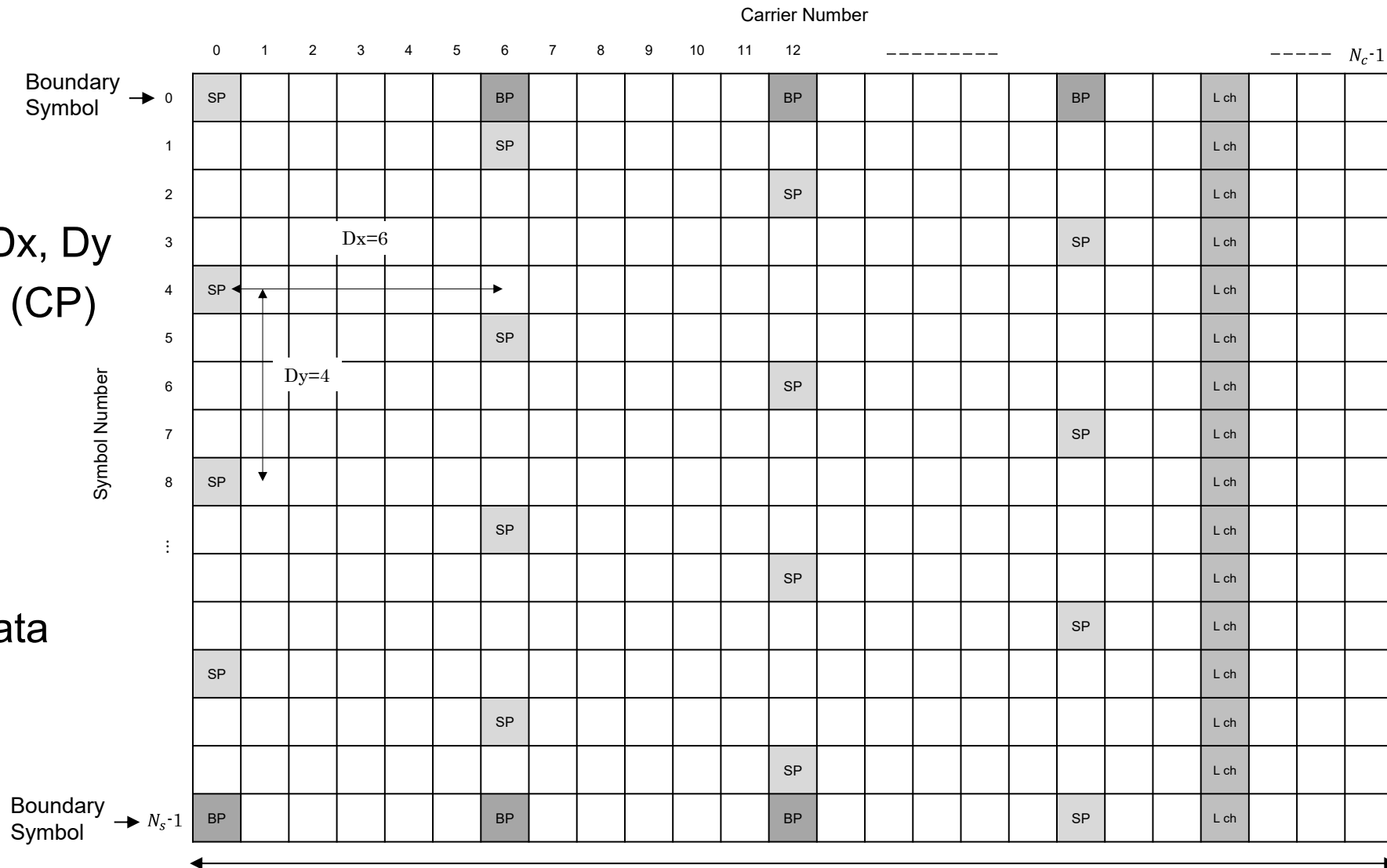
OFDM configuration

- 35 OFDM segments
 - 13 segments in ISDB-T
- Partial reception support
 - Center 9 segments can be assigned for partial reception
- Bandwidth extension
 - Total bandwidth increased by 5%
- Pilot pattern is set in each layer



Pilot

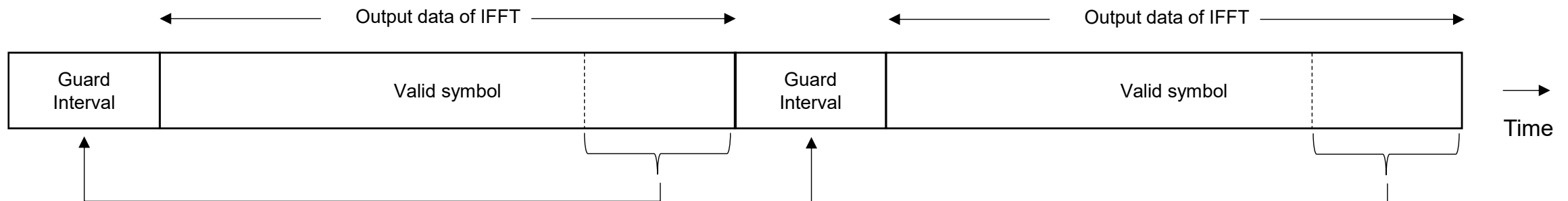
- BPSK modulation
- Scattered pilot (SP)
 - Configurable spacing: D_x , D_y
 - $D_y=1 \rightarrow$ Continual pilot (CP)
- Boundary pilot (BP)
 - Similar to edge pilots
- L Channel (L ch)
 - DBPSK modulation
 - Supports low latency data transmission



OFDM waveform generation

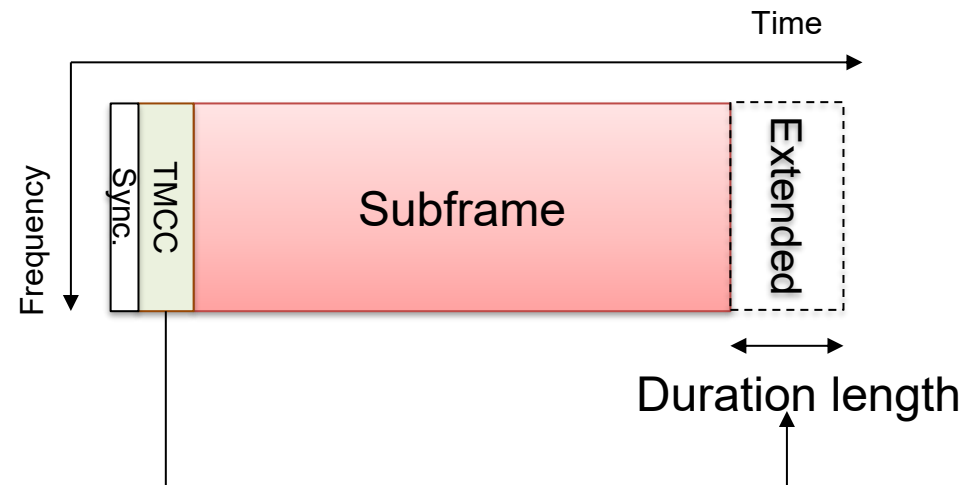
- IFFT
- Guard Interval insertion
 - GI ratios: $1/4, 1/8, 1/16, 1/32, 1/64, 1/256, 800/N_{\text{FFT}}, 1600/N_{\text{FFT}}$

N_{FFT} :FFT size



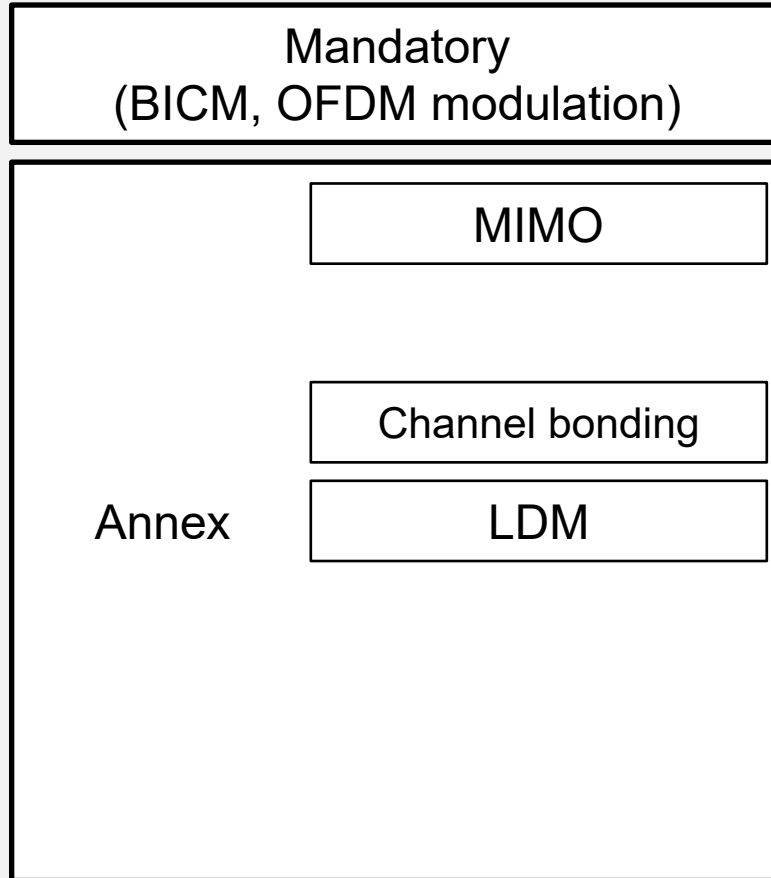
Extended duration

- Reserved for future service expansion
- Duration information is carried in TMCC
- Only the extended duration is transmitted
- Expressed as the number of FFT clocks

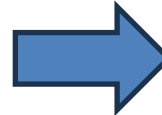


Optional features

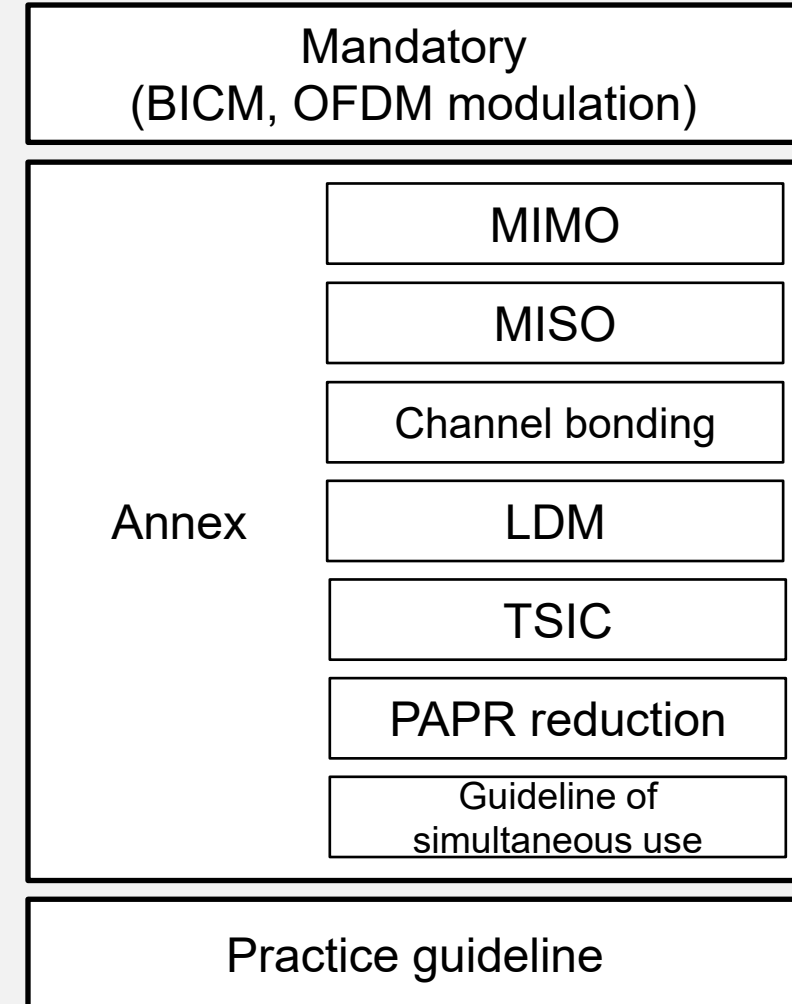
ARIB STD-B80 Version 1.0



Revised
(Apr.2026)

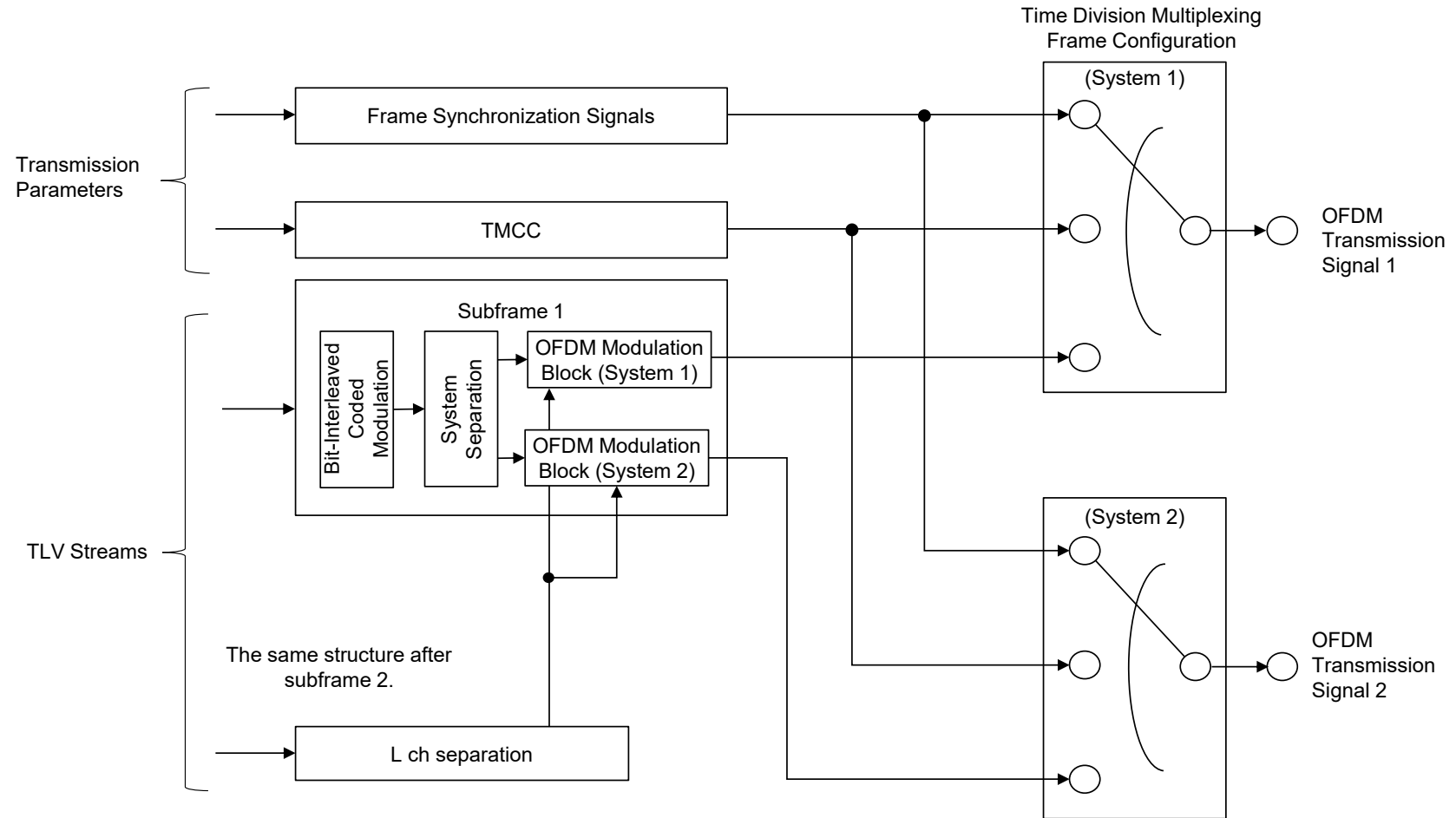


ARIB STD-B80 Version 1.1



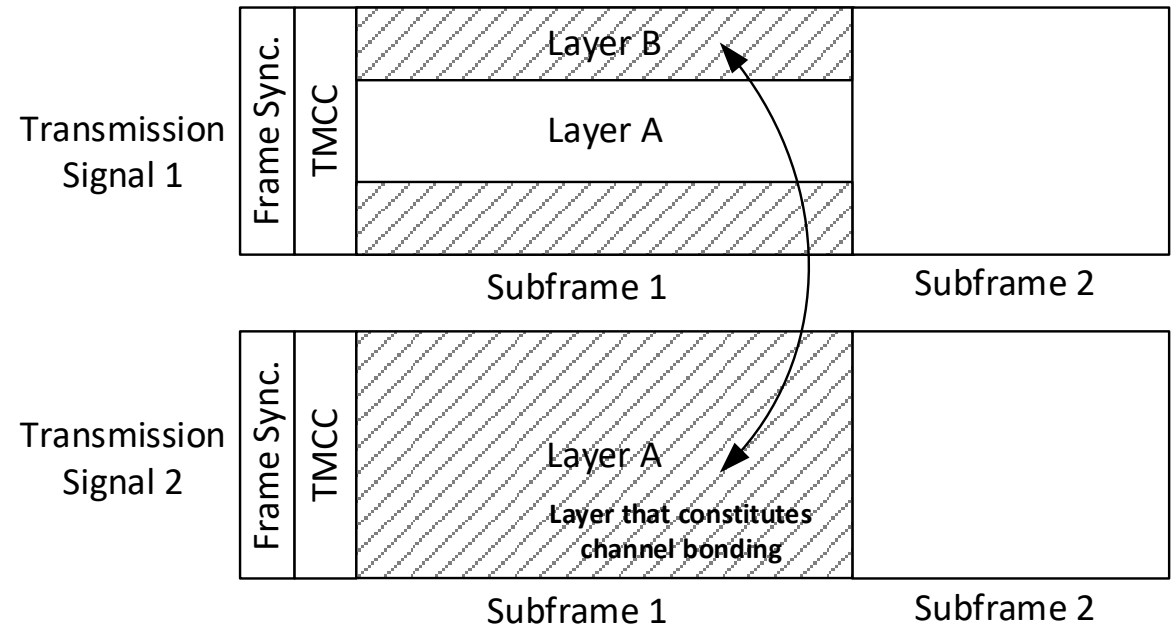
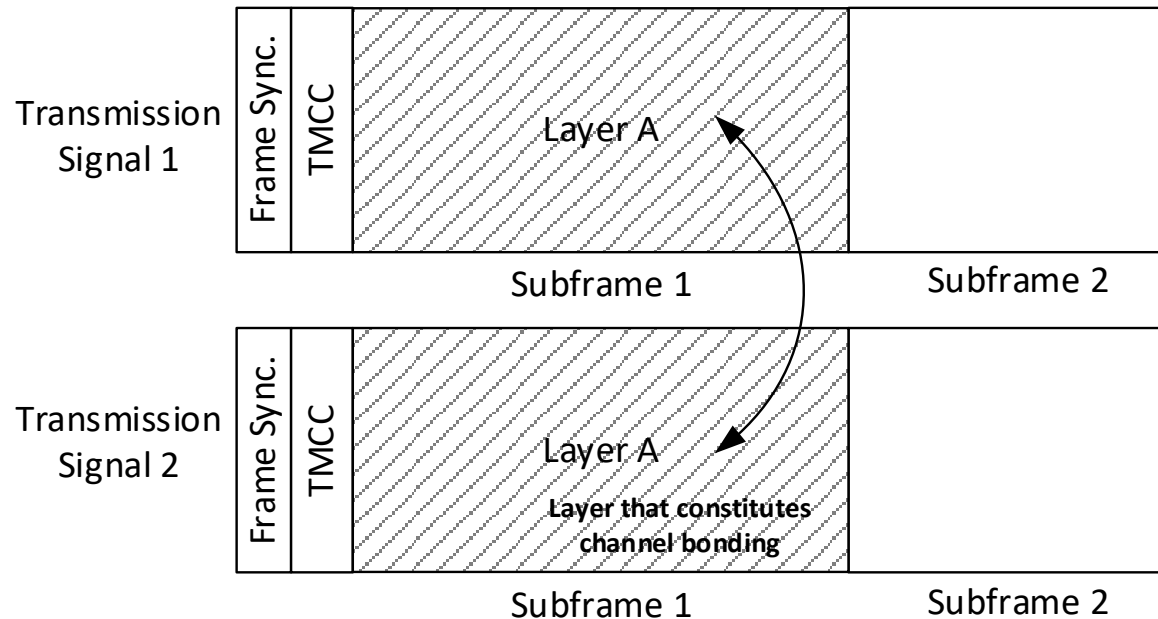
Multiple-Input Multiple-Output (MIMO)

- Supports 2x2 MIMO
- Common FSS and TMCC signaling
- One to one carrier symbol separation after BICM
- Independent frequency interleaving for system 1 and system 2



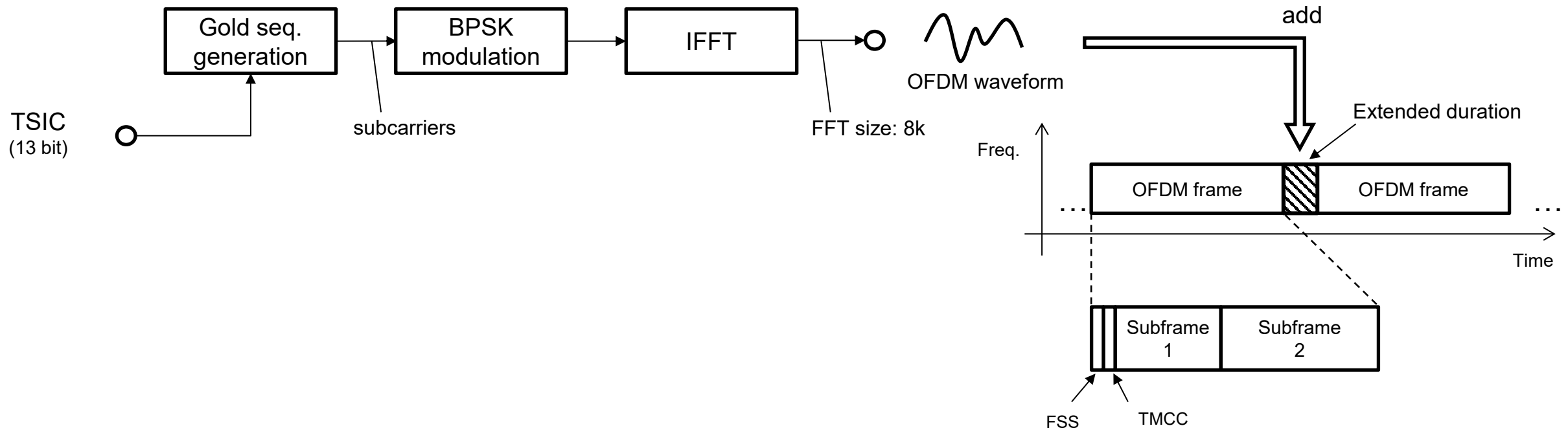
Channel Bonding (CB)

- CB combines two transmission channels to provide higher transmission capacity
 - Two-channel bonding supported
- Time-domain synchronization
 - Common duration for FSS, TMCC, Subframes and Extended
- Layer-level bonding
 - Specific layers from different channels can be combined



Transmitting Station Identification Code (TSIC)

- Defined in ARIB STD-B80 version 1.1
- Similar concept to Transmitter Identification (TxID)
- Unique signal assigned to each transmitting station
- Added within the Extended duration field



Other optional features

- Layered Division Multiplexing (LDM)^[1]
 - Injection Level : 0 dB to 30 dB
- Multiple-Input Single Output (MISO)^[1]
 - 2x1 MISO configuration
 - Alamouti coding
- Peak-to-Peak Average Ratio (PAPR) reduction
 - Active Constellation Extension (ACE)
 - Tone Reservation (TR)

[1] General information is described in Rep. BT.2485

Transmission parameters comparison

	ISDB-T	ISDB-T3
FFT size N_{FFT} (mode)	1,024(1), 4,096(2), 8,192(3)	8,192(3), 16,384(4), 32,768(5)
Number of segments	13	35
Channel bandwidth	5.57 MHz	5.83 MHz
Number of layers	Max. 3	Max. 8
FFT sampling clock	8.12698...MHz(= 512/63)	6.32098...MHz(= 512/81)
Guard interval ratio	1/4, 1/8, 1/16, 1/32	1/4, 1/8, 1/16, 1/32, 1/64, 1/256, 800/ N_{FFT} , 1600/ N_{FFT}
Carrier modulation	QPSK, DQPSK, 16QAM, 64QAM (UC)	QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM (UC or NUC)
System	SISO	SISO, MIMO, MISO

Conclusion: ISDB-T3 Transmission System Overview

- Main components
 - Frame Synchronization Signal (FSS)
 - Transmission Control Signal (TMCC)
 - Flexible subframe structure
 - Extended duration
 - Optional features
- Key enhancements
 - NUC, MIMO/MISO, LDM, IP-Native
- Standardization status
 - ARIB STD-B80 version 1.0 specifications are included in Rec. ITU-R BT.1877-4
 - Revision of BT.1877 is planned to support ARIB STD-B80 ver.1.1