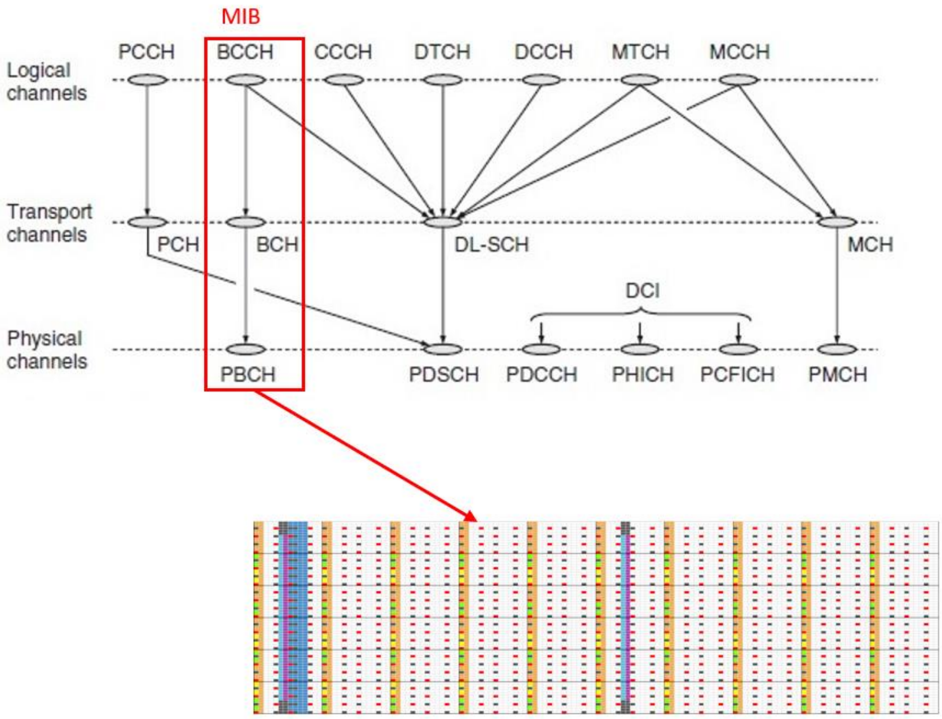
MIB (Master Information Block) in LTE

Master Information Block (MIB) is an essential component of the Long-Term Evolution (LTE) wireless communication system. It is a control channel message transmitted by the eNodeB that provides necessary information for User Equipment (UE) to synchronize with the network and access the cell. It is transmitted periodically by the eNodeB.



Key Points of MIB:

- Direction of MIB: eNodeB to UE.
- SRB used: None
- RLC Mode: TM (Transparent Mode).
- Resource Block required: 6PRB's.
- Logical channel used: BCCH
- Transport channel used: BCH
- Physical Channel used: PBCH
- Modulation required: QPSK
- Location of PBCH in resource grid: 1^{st} Subframe 2^{nd} time slot first four OFDM symbol.
- Periodicity: 40 ms at RRC layer.

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- Size of MIB: 24 Bits

In MIB 24 bits of information is divided as below:

- System Bandwidth: **3 bits**
- PHICH information: **3 bits**
  (Normal/extended PHICH: **1 bit,** PHICH Ng value: **2bits**)
- System Frame Number (SFN): **8 bits**
- Reserved bits: **10 bits**

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LTE RRC MIB Message Log Packet

Physical cell ID = 391
FREQ = 38750
SFN = 592
Number of TX Antennas = 2
DL Bandwidth = 20 MHz (100)
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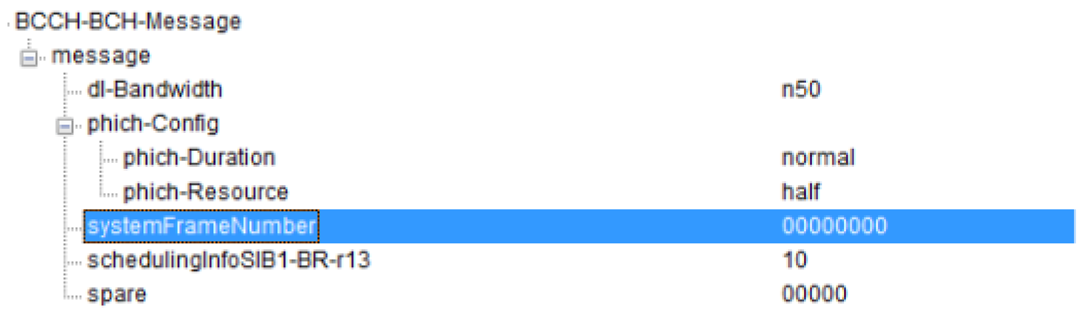
System Frame Number (SFN):

System Frame Number (SFN) is a counter that identifies each frame in the system. It is a 10-bit field that ranges from 0 to 1023 and increments by one for each frame.

Max SFN =255 (||||||||)



PHICH information

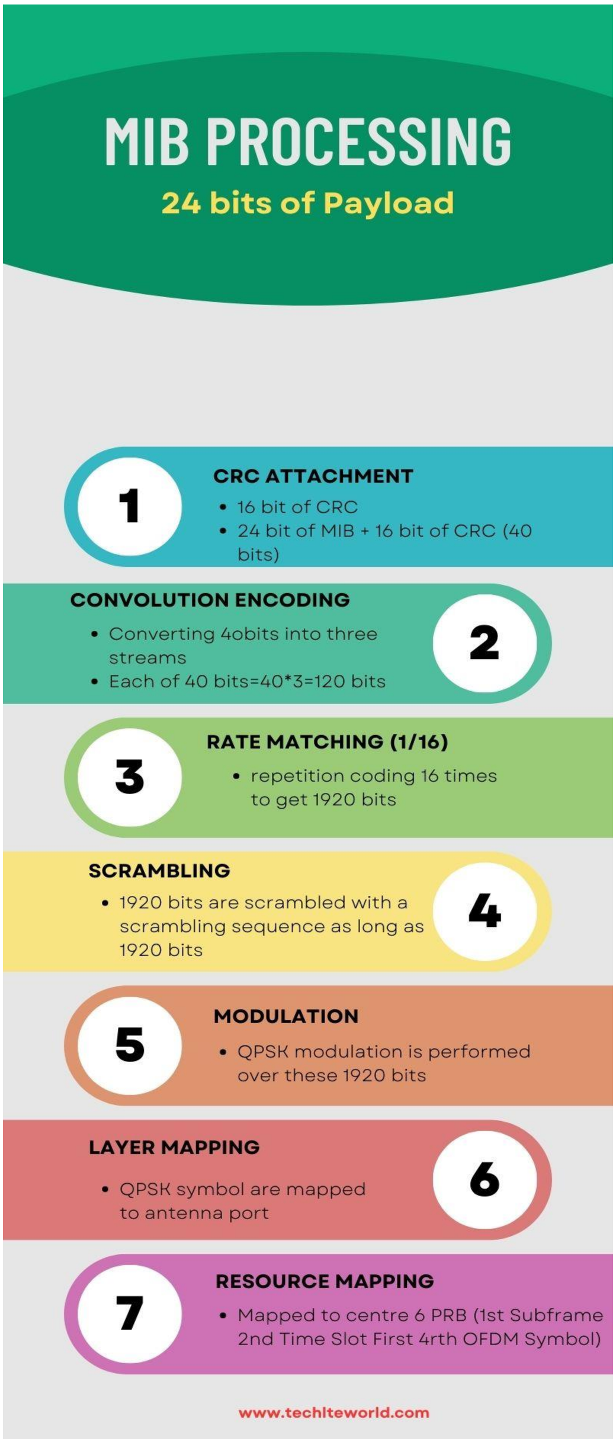
PHICH stands for Physical Hybrid ARQ Indicator Channel. The PHICH is transmitted using the same resources as the Physical Control Format Indicator Channel (PCFICH) and the Physical Downlink Control Channel (PDCCH).

PCFICH= It carries CFI (Control format Indicator).

PHICH Ng value =number of PHICH group used in 1st symbol) (1,1/2,1/6,2)

Let’s Discuss how to get MIB after every 40 ms or we can say PBCH transmission.

So, we will go step by step process that how 24 bits of data is received from upper layer to physical layer. The steps involved are mentioned below –



1. **CRC Attachment**: To ensure reliable transmission of the MIB, the eNodeB appends a Cyclic Redundancy Check (CRC) to the MIB message. The CRC is a type of error-detecting code that is added to the MIB to detect any errors that may have occurred during transmission.16 bits of CRC is scrabbled with antenna. The length of the CRC code used in the MIB is 16 bits. This length was chosen based on the tradeoff between error detection capability and the overhead introduced by the CRC code.

Now the 24 bits of MIB payload attached to 16 bits of generated CRC and overall data becomes

24 bits payload+16 bits of CRC =40 bits

2. **Convolutional encoding**: the convolutional encoder used for MIB generation employs a rate 1/3 code, which means that for every three input bits, the encoder generates one parity bit. The rate 1/3 code used for convolutional encoding in LTE MIB generation provides a balance between error correction capabilities and overhead.

After convolution encoding is performed over the 40 bits and the output is 3 streams of 40 bits each.

Now 40 bits of data becomes 120 bits (40*3 bits)

40 bits*3 = 120 bits

3. **Rate matching**: The rate matching is a repetition coding, where the 3 streams of size 120 bits (40x3bits) is repeated 16 times to get 1920 bits.

120 bits*16 = 1920 bits

4. **Scrambling:** scrambling is used to randomize the coded MIB sequence before transmission. The coded MIB sequence is multiplied by the scrambling sequence bit by bit, which randomizes the 1920 bits in the sequence. The scrambled MIB sequence is then transmitted over the air interface which scrabbled with PCI.

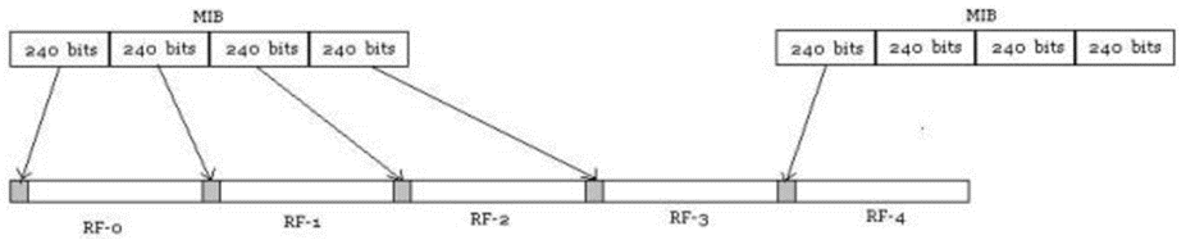
5. **Modulation:** As we know while processing MIB we use QPSK modulation**.** QPSK modulation is performed on 1920 bits after which we got 960 QPSK symbol.

1920 bits performed QPSK= 960 QPSK Symbol

6. **Layer Mapping:** 920 QPSK symbols are then mapped to antenna ports**.**
7. **Resource Mapping:** Finally, 920 QPSK symbols are mapped to centre 6PRB OF 1st Subframe 2nd Time slot first four OFDM Symbol i.e 0,1,2,3.

The fundamental process for PBCH encoding involves dividing the PBCH modulation buffer into four sub-buffers, each containing 240 complex symbols. This is necessary because the PBCH needs to be transmitted every 10 milliseconds on subframe 0 of all radio frames. Each sub-buffer is then transmitted over PBCH, one after the other.

After the transmission of the last sub-buffer, a new Master Information Block (MIB) arrives from the higher layer. The newly arrived MIB is encoded using the same method as before, and the process of dividing the PBCH modulation buffer into sub-buffers and transmitting them over PBCH continues. This ensures that the MIB is reliably transmitted over the air interface, meeting the requirements of the LTE standard.



- A new MIB is generated by higher layers when the Radio frame number is a multiple of 4 (RF%4=0).
- The first subframe of each radio frame or subframe-0 is represented by the grey boxes in the diagram.
- The PBCH output is 960 complex symbols long, divided into 4 parts, each transmitted in consecutive radio frames.
- The first 240 bits of the PBCH are transmitted in RF-0, followed by the next 240 bits in RF-1, and so on.
- Each individual PBCH can be decoded independently, meaning that if the UE finds the PBCH in RF-0, it can decode all the contents of MIB without waiting for the parts of the PBCH in the coming radio frames.