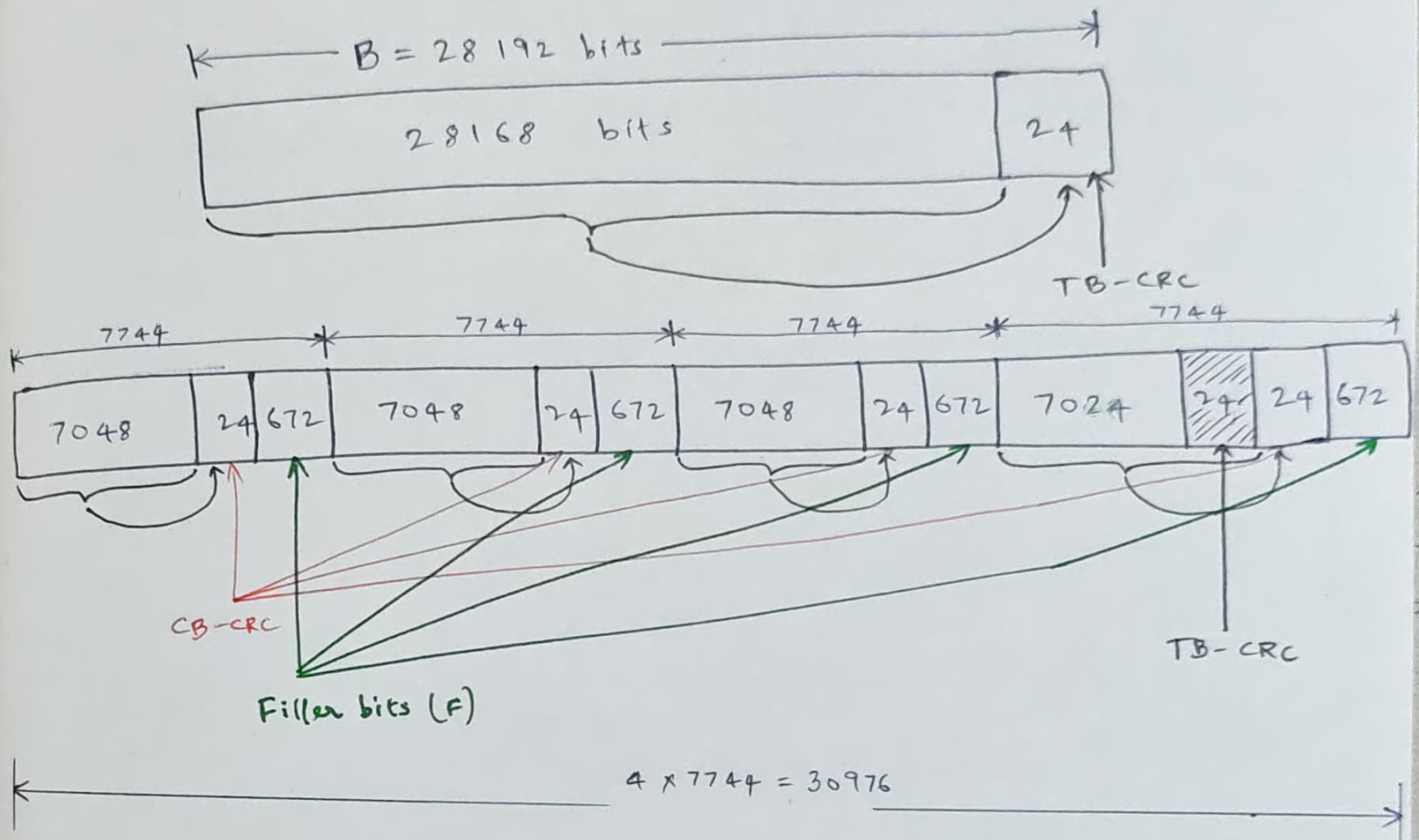
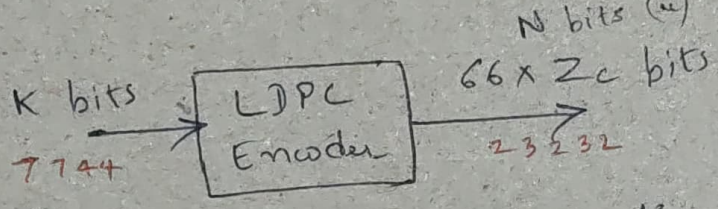
Our running example from last section.



- Assume a user is allocated 70 RB's over a slot of 14 symbols.
- MCS-16 (16-QAM), which has a code rate of $\frac{658}{1024} = 0.642$.
- No. of code blocks, $C = 4$;
- Code block size without filler bits $K' = 7072$ bits
- Code block size with filler bits $K = 7072 + 672 = 7744$ bits.
- CRC size $L = 24$ bits, Lifting size $Z_c = 352$.

LDPC coding in the standard

- LDPC encoder input = K bits
- LDPC encoder output length
  - $N = 66 Z_c$ bits for base graph 1
  - $N = 50 Z_c$ bits for base graph 2
- For our example, LDPC encoder output for each segmented code block
  $$N_r = 66 \times 352 = 23232.$$



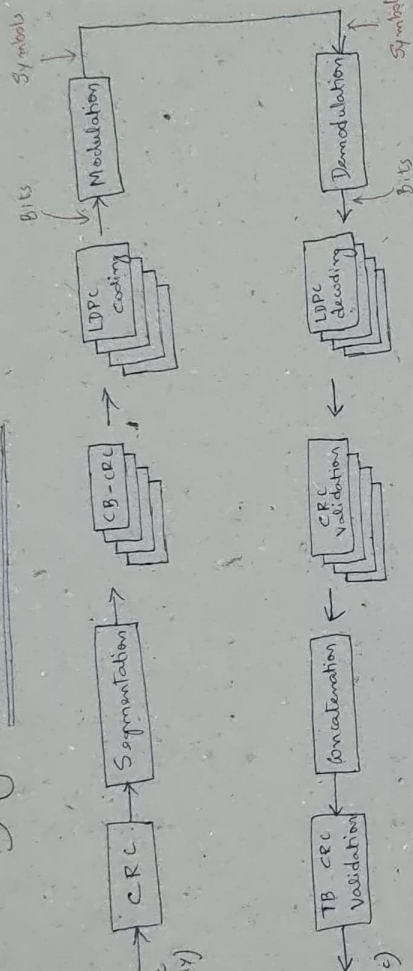
$$\text{Code Rate, } r = \frac{K}{66 \times Z_c} = \frac{7744}{23232} = \frac{1}{3}$$

- Filler bits are replaced with zeros while encoding and added back after encoding
- Rate of each code block $= \frac{7744}{23232} = \frac{1}{3}$

mother-code-rate

- Bits input to LDPC encoder are denoted as $c_0, c_1, c_2, \ldots, c_{K-1}$. Subscript r is dropped while feeding data to LDPC encoder
- Bits output from LDPC encoder are denoted as $d_0, d_1, d_2, \ldots, d_{N-1}$.

5G Transceiver Chain



- Threshold the equalized symbols to the nearest symbol.
- Demap the symbols into bits.

- 5G NR allows 4/16/64/256-QAM modulation
- Demodulator detects the Bits from 4/16/64/256-QAM modulated symbols.
- LDPC decoder works on the demodulated bits and not symbols, because it is not practical to design decoder for different modulation schemes.

5G Modulation

- 5G allows 4/16/64/256-QAM for data.

For example, QPSK mapping

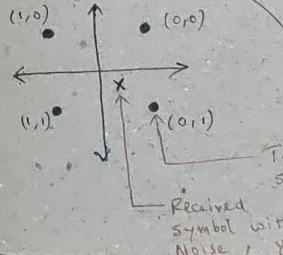
b(i), b(i+1)	I	Q
0 0	$1/\sqrt{2}$	$1/\sqrt{2}$
0 1	$1/\sqrt{2}$	$-1/\sqrt{2}$
1 0	$-1/\sqrt{2}$	$1/\sqrt{2}$
1 1	$-1/\sqrt{2}$	$-1/\sqrt{2}$

(Refer Sec. 5.1 of 38.211)

(ii) QPSK takes 2 bits (Spectral efficiency = 2 bps/Hz) and maps them to a symbol.

Similarly 16-QAM → 4 bps/Hz
64-QAM → 6 bps/Hz
and so on...

QPSK demodulation



- To detect the transmitted symbol, "nearest distance detection rule" is applied.

(ii) Calculate the distance of the received symbol × from all the possible symbols •. The symbol with minimum distance is declared as the transmitted symbol.