ETSI TS 138 212 V18.4.0 (2024-10)

5G;
NR;
Multiplexing and channel coding
(3GPP TS 38.212 version 18.4.0 Release 18)

Reference

RTS/TSGR-0138212vi40

Keywords

5G

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Legal Notice

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found under https://webapp.etsi.org/key/queryform.asp.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

should indicates a recommendation to do something

should not indicates a recommendation not to do something

may indicates permission to do something

need not indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can indicates that something is possible

cannot indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

will indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

will not indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document specifies the coding, multiplexing and mapping to physical channels for 5G NR.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] void.

[3] void.

[4] 3GPP TS 38.211: "NR; Physical channels and modulation".

[5] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[6] 3GPP TS 38.214: "NR; Physical layer procedures for data".

[7] void.

[8] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[9] 3GPP TS 38.331: "NR; Radio Resource Control (RRC) protocol specification".

[10] 3GPP TS 38.473: "NG-RAN; F1 Application Protocol (F1AP)".

[11] 3GPP TS 36.212: "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding".

[12] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[13] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[14] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

BCH	Broadcast Channel
CAPC	Channel Access Priority Class
CBG	Code Block Group
CBGTI	Code Block Group Transmission Information
CG	Configured Grant
CG-DFI	CG - Downlink Feedback Information
CG-UCI	CG - Uplink Control Information
CORESET	Control Resource Ret
COT	Channel Occupancy Time
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
CRI	CSI-RS Resource Indicator
CSI	Channel State Information
CSI-RS	CSI - Reference Signal
DAI	Downlink Assignment Index
DCI	Downlink Control Information
DL	Downlink
DL-SCH	Downlink - Shared Channel
DMRS	Demodulation Reference Signal
HARQ	Hybrid Automatic repeat Request
HARQ-ACK	Hybrid Automatic repeat Request - Acknowledgement
LDPC	Low Density Parity Check
LI	Layer Indicator
MBS	Multicast Broadcast Services
MCS	Modulation and Coding Scheme
NCR	Network-controlled repeater
OFDM	Orthogonal Frequency Division Multiplex
PBCH	Physical Broadcast Channel
PCH	Paging Channel
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PMI	Precoding Matrix Indicator
PRB	Physical Resource Block
PRACH	Physical Random Access Channel
PSBCH	Physical Sidelink Broadcast Channel
PSCCH	Physical Sidelink Control Channel
PSFCH	Physical Sidelink Feedback Channel
PSSCH	Physical Sidelink Shared Channel
PTRS	Phase-Tracking Reference Signal
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
RACH	Random Access Channel
RI	Rank Indicator
RSRP	Reference Signal Received Power
SCI	Sidelink Control Information
SFCI	Sidelink Feedback Control Information
SFN	System Frame Number
SL	Sidelink
SL-BCH	Sidelink - Broadcast Channel
SL PRS	Sidelink Positioning Reference Signal
SL-SCH	Sidelink - Shared Channel
SR	Scheduling Request
SRS	Sounding Reference Signal
SS	Synchronisation Signal
SUL	Supplementary Uplink

TCI	Transmission Configuration Indicator
TPC	Transmit Power Control
TrCH	Transport Channel
UCI	Uplink Control Information
UE	User Equipment
UL	Uplink
UL-SCH	Uplink Shared Channel
UTO-UCI	Unused Transmission Occasion - Uplink Control Information
VRB	Virtual Resource Block
ZP CSI-RS	Zero power CSI-RS

4 Mapping to physical channels

4.1 Uplink

Table 4.1-1 specifies the mapping of the uplink transport channels to their corresponding physical channels. Table 4.1-2 specifies the mapping of the uplink control channel information to its corresponding physical channel.

Table 4.1-1

TrCH	Physical Channel
UL-SCH	PUSCH
RACH	PRACH

Table 4.1-2

Control information	Physical Channel
UCI	PUCCH, PUSCH

4.2 Downlink

Table 4.2-1 specifies the mapping of the downlink transport channels to their corresponding physical channels. Table 4.2-2 specifies the mapping of the downlink control channel information to its corresponding physical channel.

Table 4.2-1

TrCH	Physical Channel
DL-SCH	PDSCH
BCH	PBCH
PCH	PDSCH

Table 4.2-2

Control information	Physical Channel
DCI	PDCCH

4.3 Sidelink

Table 4.3-1 specifies the mapping of the sidelink transport channels to their corresponding physical channels. Table 4.3-2 specifies the mapping of the sidelink control information and sidelink feedback control information to their corresponding physical channels.

Table 4.3-1

TrCH	Physical Channel
SL-SCH	PSSCH
SL-BCH	PSBCH

Table 4.3-2

Control information	Physical Channel
1st-stage SCI	PSCCH
2nd-stage SCI	PSSCH
SFCI	PSFCH

5 General procedures

Data and control streams from/to MAC layer are encoded /decoded to offer transport and control services over the radio transmission link. Channel coding scheme is a combination of error detection, error correcting, rate matching, interleaving and transport channel or control information mapping onto/splitting from physical channels.

5.1 CRC calculation

Denote the input bits to the CRC computation by $a_0, a_1, a_2, a_3, ..., a_{A-1}$, and the parity bits by $p_0, p_1, p_2, p_3, ..., p_{L-1}$, where A is the size of the input sequence and L is the number of parity bits. The parity bits are generated by one of the following cyclic generator polynomials:

- $g_{\text{CRC24A}}(D) = [D^{24} + D^{23} + D^{18} + D^{17} + D^{14} + D^{11} + D^{10} + D^{7} + D^{6} + D^{5} + D^{4} + D^{3} + D + 1]$ for a CRC length $L = 24$;
- $g_{\text{CRC24B}}(D) = [D^{24} + D^{23} + D^{6} + D^{5} + D + 1]$ for a CRC length $L = 24$;
- $g_{\text{CRC24C}}(D) = [D^{24} + D^{23} + D^{21} + D^{20} + D^{17} + D^{15} + D^{13} + D^{12} + D^{8} + D^{4} + D^{2} + D + 1]$ for a CRC length $L = 24$;
- $g_{\text{CRC16}}(D) = [D^{16} + D^{12} + D^{5} + 1]$ for a CRC length $L = 16$;
- $g_{\text{CRC11}}(D) = [D^{11} + D^{10} + D^{9} + D^{5} + 1]$ for a CRC length $L = 11$;
- $g_{\text{CRC6}}(D) = [D^{6} + D^{5} + 1]$ for a CRC length $L = 6$.

The encoding is performed in a systematic form, which means that in GF(2), the polynomial:

$$a_0 D^{A+L-1} + a_1 D^{A+L-2} + ... + a_{A-1} D^{L} + p_0 D^{L-1} + p_1 D^{L-2} + ... + p_{L-2} D^{1} + p_{L-1}$$

yields a remainder equal to 0 when divided by the corresponding CRC generator polynomial.

The bits after CRC attachment are denoted by $b_0, b_1, b_2, b_3, ..., b_{B-1}$, where $B = A + L$. The relation between a_k and b_k is:

$b_k = a_k$ for $k = 0,1,2,...,A-1$

$b_k = p_{k-A}$ for $k = A, A+1, A+2,..., A+L-1$.

5.2 Code block segmentation and code block CRC attachment

5.2.1 Polar coding

The input bit sequence to the code block segmentation is denoted by $a_0, a_1, a_2, a_3, ..., a_{A-1}$, where $A > 0$.

if $I_{seg} = 1$

Number of code blocks: $C = 2$;

else

Number of code blocks: $C = 1$

end if

$A' = \lceil A/C \rceil \cdot C$;

for $i = 0$ to $A' - A - 1$

$a'_i = 0$;

end for

for $i = A' - A$ to $A' - 1$

$a'_i = a_{i-(A'-A)}$;

end for

$s = 0$;

for $r = 0$ to $C - 1$

for $k = 0$ to $A'/C - 1$

$c_{rk} = a'_s$;

$s = s + 1$;

end for

The sequence $c_{r0}, c_{r1}, c_{r2}, c_{r3}, ..., c_{r(A'/C-1)}$ is used to calculate the CRC parity bits $p_{r0}, p_{r1}, p_{r2}, ..., p_{r(L-1)}$ according to Clause 5.1 with a generator polynomial of length L.

for $k = A'/C$ to $A'/C + L - 1$

$c_{rk} = p_{r(k-A'/C)}$;

end for

end for

The value of A is no larger than 1706.

5.2.2 Low density parity check coding

The input bit sequence to the code block segmentation is denoted by $b_0, b_1, b_2, b_3, ..., b_{B-1}$, where $B > 0$. If B is larger than the maximum code block size K_{cb}, segmentation of the input bit sequence is performed and an additional CRC sequence of $L = 24$ bits is attached to each code block.

For LDPC base graph 1, the maximum code block size is:

- $K_{cb} = 8448$.

For LDPC base graph 2, the maximum code block size is:

- $K_{cb} = 3840$.

Total number of code blocks C is determined by:

if $B \le K_{cb}$

$L = 0$

Number of code blocks: $C = 1$

$B' = B$

else

$L = 24$

Number of code blocks: $C = \lceil B / (K_{cb} - L) \rceil$.

$B' = B + C \cdot L$

end if

The bits output from code block segmentation are denoted by $c_{r0}, c_{r1}, c_{r2}, c_{r3}, ..., c_{r(K_r - 1)}$, where $0 \le r < C$ is the code block number, and $K_r = K$ is the number of bits for the code block number r .

The number of bits K in each code block is calculated as:

$K' = B' / C$;

For LDPC base graph 1,

$K_b = 22$.

For LDPC base graph 2,

if $B > 640$

$K_b = 10$;

elseif $B > 560$

$K_b = 9$;

elseif $B > 192$

$K_b = 8$;

else

$K_b = 6$;

end if

find the minimum value of Z in all sets of lifting sizes in Table 5.3.2-1, denoted as Z_c , such that $K_b \cdot Z_c \ge K'$, and set $K = 22Z_c$ for LDPC base graph 1 and $K = 10Z_c$ for LDPC base graph 2;