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Technical Report

MFA
Uni5G™ Technology Blueprints for 5G Industrial Devices and Ecosystem

Release 1.0

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Foreword

This Technical Report has been produced by the MFA.

The contents of the present document are subject to continuing work within the Technical Specification Group (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.

1 Scope

This document classifies selected 3GPP Rel-15 User Equipment (UE) feature groups [1] into functionalities for the purposes of identifying UE blueprints suitable for deployments in 5G private networks. The functionalities are further mapped to four specialized feature categories, defined to match the most relevant attributes for 5G NR private networks deployments.

Recommended UE blueprints indicate which of the four specialized feature categories are suitable for considered deployments and use cases. The focus of this document is Layer 1 features.

For each listed NR UE feature group, the corresponding field name of UE capability, as specified in TS 38.331 [2] is also captured in this document.

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 38.822: “User Equipment (UE) feature list”, v16.1.0 (2021-09)”.

[2] 3GPP TS 38.331: “NR; Radio Resource Control (RRC) protocol specification”.

[3] 3GPP TR 21.905: “Vocabulary for 3GPP Specifications”.

[4] mf2021.005.00: “Beecham research report”.

[5] mf2022.001.00: “Nokia – Proposals for blueprint examples”.

3 Definitions and Abbreviations

3.1 Definitions

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

example: text used to clarify abstract rules by applying them literally.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [3] 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 [3].

Abbreviation	Definition
eMBB	Enhanced Mobile Broadband
FG	Feature Group
MCL	Maximum Coupling Loss
MFA	MulteFire Alliance
NR	New Radio
RWG	Radio Working Group
TSG	Technical Specification Group
UE	User Equipment
URLLC	Ultra-Reliable Low Latency Communications

4 Classification of UE Features

UE features suitable for 5G NR private network deployments may vary depending on the deployment type and specific use cases. To identify features suitable for 5G industrial devices and to help develop the corresponding device ecosystem, Beecham research has conducted a study by interviewing seven different sectors when deployment of 5G private networks is suitable. The interviewed sectors included hospitals, oil and gas, mining, agriculture, airport, warehouses, and ports, and the findings were summarized in [4].

Based on the findings in [4], and accounting for the eMBB service as a baseline, the RWG identified the following attributes as the most relevant for 5G private networks for industrial applications:

- Coverage
- Reliability
- Connection Density
- Latency

Each of these attributes is associated with a list of UE feature groups (FG)[1] [1], and mapping is based on the criteria given in **Table *1***.

The FGs are associated with the attributes if the following requirements are met:

- The FGs that improve UE performance with respect to associated attribute under most common deployment scenarios and use cases are included.
- The FGs that may improve performance under some scenarios and degrade performance under some others are not included.

[1] Unless indicated otherwise, FG index refers Layer 1 FG index.

Table 1: Criteria to Map Features to Attributes

Attribute	Criteria
Coverage	Feature groups that can support MCL larger than baseline eMBB
Reliability	Feature groups that can be used to achieve improved reliability than baseline eMBB
Connection Density	Feature groups that relieve control channels from being the performance bottleneck and that optimize UE performance for scenarios where pre-emption need to be utilized.
Latency	Feature groups that can be used to achieve lower latency than baseline eMBB

To ease the understanding of the categorized FGs, FGs are further grouped into feature categories based on the functionality they provide before being associated to the corresponding attribute. Each feature category can be mapped to multiple attributes. **Table *2*** lists the feature categories, the associated definition based on the functionality they provide, and associated FGs.

Table 2: Definitions of Feature Categories

Index	Name	Description	Associated FGs†
C1	Ultra-reliable CQI/MCS	CQI and MCS tables that facilitate ultra-reliable transmission of data where BLER target is several orders of magnitude lower than that of eMBB.	2-32c, 5-34, 5-34a, 5-34b, 5-34c
C2	Mini-slot	Minimum scheduling unit, smaller than regular slot; A “mini-slot” can start at any OFDM.	5-6, 5-6a, 5-11, 5-11a, 5-11b, 5-12, 5-12a, 5-12b
C3	PDCCH processing	Processing requirement for DCI reception at any OFDM symbol in a slot.	3-2, 3-5, 3-5b
C4	UL configured grant	UL configured grant enables UE to transmit periodic traffic without control signalling to request and grant UL resources.	5-19, 5-20, 3-6*
C5	DL semi-persistent scheduling	DL SPS enable gNB to transmit periodic low-rate traffic over pre-granted PDSCH resources to avoid transmitting DCI for DL data channel assignment.	5-18
C6	Repetition	PHY/MAC repetition schemes for duplication of critical data and control; duplication may be over different time-frequency resources.	5-14, 5-16, 5-17, 5-17a
C7	HARQ-ACK	To reduce round-trip time, HARQ-ACK is allowed to be piggyback on a PUSCH that is different from the starting OFDM symbol of PUCCH that HARQ-ACK would have been otherwise transmitted on.	4-28
C8	UE processing capability 2	A UE with processing capability 2 has reduced PDSCH and PUSCH processing time.	5-5a, 5-13, 5-13a, 5-13c, 5-5c, 5-13d, 5-13e, 5-13f
C9	PDCP duplication	PDCP duplication refers to implementation of parallel and redundant PDCP protocol, which diversifies transmission of data over multiple links to improve reliability.	1-6*
C10	Pre-emption indication	Pre-emption indication for DL.	5-21

Notes:
* Indicates Layer 2 FG index.
† Associated feature groups from 3GPP TR 38.822 [1].

Table *3* presents the association between feature categories and attributes. The current version of the technical report includes only FGs defined in Release 15 of 3GPP specification [1] that for reference is provided in Annex A.

Table 3: Association of Feature Categories and Attributes

Feature Category	Coverage	Reliability	Connection Density	Latency
Ultra-reliable CQI/MCS	X	X	–	–
Mini-slot	–	–	–	X
PDCCH processing	–	–	X	X
UL configured grant	–	–	X	X
DL semi-persistent scheduling	–	–	X	–
Repetition	X	X	–	–
HARQ-ACK	–	–	–	X
UE processing capability 2	–	–	–	X
PDCP duplication	–	X	–	–
Pre-emption indication	–	–	X	–

5 UE blueprints

Table *4* presents the list of recommended UE blueprints families and shows the association between the UE blueprint families, feature categories, and corresponding attributes. Each UE blueprint family includes eMBB features; however, the selection of eMBB features is outside of the scope of this document.

- Feature categories are aggregated and presented as a list of indices based on the attribute they are associated with.
- Each UE blueprint family contains multiple lists.
- For a given UE blueprint family, feature categories are grouped into lists based on the number of attributes they are associated with.
- The base feature category list consists of feature categories associated with more than one attribute.
- The extended feature category lists are associated with a single attribute only.
- A valid UE blueprint contains FG(s) associated with feature category(ies) within at least the base feature category list(s) mapped to the corresponding UE blueprint family.

Table 4: Recommended UE Blueprint Families

UE Blueprint Family	eMBB	Latency	Reliability	Coverage	Connection Density
F0	X	–	–	–	–
F1	X	–	{C1, C6}, {C9}	{C1, C6}	–
F2	X	{C3, C4}, {C2, C7, C8}	–	–	{C3, C4}, {C5, C10}
F3	X	{C3, C4}, {C2, C7, C8}	{C1, C6}, {C9}	{C1, C6}	{C3, C4}, {C5, C10}

Error! Not a valid bookmark self-reference. presents the mapping between UE blueprint families and the corresponding base and extended feature category lists and candidate FGs. Listed UE blueprint families may not fully imply support for Ultra-Reliable Low Latency Communications (URLLC) service for manufacturing. To meet the requirements for URLLC service for manufacturing, it is necessary to define the minimum set of supported FGs. The

current classification and selection of FGs in the base feature category do not imply the necessary supported FGs for URLLC.

Table 5: Mapping Between UE Blueprint Families and Candidate FGs

UE Blueprint Family	Targeted Attributes	Feature Categories Lists		Complete List of Corresponding Candidate FG Indices
		Base	Extended	
F1	Coverage, Reliability	{C1, C6}	{C9}	{2-32c, 5-34, 5-34a, 5-34b, 5-34c, 5-17, 5-17a, 5-14}, {1-6*}
F2	Connection density, Latency	{C3, C4}	{C2, C5, C7, C8, C10}	{3-2, 3-5, 3-5b, 5-19, 5-20,3-6*} {4-28, 5-18, 5-21, 5-6, 5-6a, 5-11, 5-11a, 5-11b, 5-12, 5-12a, 5-12b, 5-5a, 5-5c, 5-13, 5-13a, 5-13c, 5-13d, 5-13e, 5-13f}
F3	Coverage, Reliability, Connection density, Latency	{C1, C6}, {C3, C4}	{C9} {C2, C5, C7, C8, C10}	{2-32c, 5-34, 5-34a, 5-34b, 5-34c, 5-17, 5-17a, 5-14}, {3-2, 3-5, 3-5b, 5-19, 5-20, 3-6*}, {1-6*} {4-28, 5-18, 5-21, 5-6, 5-6a, 5-11, 5-11a, 5-11b, 5-12, 5-12a, 5-12b, 5-5a, 5-5c, 5-13, 5-13a, 5-13c, 5-13d, 5-13e, 5-13f}

Note: * Indicates Layer 2 FG index.

UE blueprints examples consist of a list of selected FGs. Recommended UE blueprints examples are outside the scope of this document. The examples shown in **Table *6*** are for illustrative purposes only.

Table 6: UE Blueprint Examples†

UE Blueprint	Class	Targeted Attributes	Selected FG Indices
F1.0	Basic	Coverage, Reliability	{5-17, 5-17a, 2-32c, 5-34, 5-34a}
F1.1	Advanced	Coverage, Reliability	{5-17, 5-17a, 2-32c, 5-34, 5-34a, 1-6*}
F2.0	Basic	Connection density, Latency	{3-2, 5-20, 3-6*}
F2.1	Advanced	Connection density, Latency	{3-2, 5-20, 3-6*, 5-18, 5-6, 5-6a, 5-11, 5-12, 4-28, 5-21, 5-5a, 5-5c}
F3.0	Basic	Coverage, Reliability, Connection density, Latency	{5-17, 5-17a, 2-32c, 5-34, 5-34a, 3-2, 5-20, 3-6*}
F.3.1	Advanced	Coverage, Reliability, Connection density, Latency	{5-17, 5-17a, 2-32c, 5-34, 5-34a, 1-6*, 3-2, 5-20, 3-6*, 5-18, 5-6, 5-6a, 5-11, 5-12, 4-28, 5-21}
F3.2	Ultimate	Coverage, Reliability, Connection density	{5-17, 5-17a, 5-14, 5-16, 2-32c, 5-34, 5-34a, 5-34b, 5-34c, 1-6*, 3-2, 3-5b, 5-20, 3-6*, 5-18, 5-6, 5-6a, 5-5a, 5-5c, 5-11, 5-11a, 5-12, 5-12a, 4-28, 5-21}

Notes:
* Indicates Layer 2 FG index.
† UE Blueprint examples from mf2022.001.00 [5].

Annex A:
3GPP 5G NR Release 15 Candidate UE Feature Groups

A.1 Layer-1 UE Features

Table A.1-1 provides the list of Layer-1 features mapped to attributes, as shown in [1] and the corresponding UE capability field name, as specified in TS 38.331 [2].

Table A.1-1: Layer-1 Feature List–Ultra-Reliable CQI/MCS

Index	Feature Group	Components	Field Name*	Parent IE*
2-32c	New CQI table	CQI table with target BLER of 10^-5	*cqi-TableAlt*	*Phy-ParametersFRX-Diff*
5-34	New 64QAM MCS table for PDSCH	New 64QAM MCS table for PDSCH	*dl-64QAM-MCS-TableAlt*	*Phy-ParametersFRX-Diff*
5-34a	New 64QAM MCS table for PUSCH	New 64QAM MCS tables for PUSCH with and without transform precoding respectively	*ul-64QAM-MCS-TableAlt*	*Phy-ParametersFRX-Diff*
5-34b†	Dynamic indication of MCS table with MCS-C-RNTI for PDSCH	Dynamic indication of MCS table using MCS-C-RNTI for PDSCH	*dl-MCS-TableAlt-DynamicIndication*	*FeatureSetDownlink-v1540*
5-34c‡	Dynamic indication of MCS tables with MCS-C-RNTI for PUSCH	Dynamic indication of MCS tables using MCS-C-RNTI for PUSCH	*ul-MCS-TableAlt-DynamicIndication*	*FeatureSetUplink-v1540*

Notes:
* Field Name and Parent IE from 3GPP TS 38.331 [2].
† Index 5-34 is a prerequisite feature group for Index 5-34b.
‡ Index 5-34a is a prerequisite feature group for Index 5-34c.

Table A.1-2: Layer-1 Feature List–PDCCH Processing

Index	Feature Group	Components	Field Name*	Parent IE*
3-2	PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot	For a given UE, all search space configurations are within the same span of 3 consecutive OFDM symbols in the slot	*pdcchMonitoringSingleOccasion*	*Phy-ParametersFR1*

3-5	For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2	For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2	*pdcch-MonitoringAnyOccasions* {
			
			3-5. *withoutDCI-Gap*
			
			3-5a. *withDCI-Gap*
			
			}
				FeatureSetDownlink

3-5b†	All PDCCH monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a span gap	• PDCCH monitoring occasions of FG-3-1, plus additional PDCCH monitoring occasion(s) can be any OFDM symbol(s) of a slot for Case 2
		• For any two PDCCH monitoring occasions belonging to different spans, where at least one of them is not the monitoring occasions of FG-3-1, in same or different search spaces, there is a minimum time separation of X OFDM symbols (including the cross-slot boundary case) between the start of two spans, where each span is of length up to Y consecutive OFDM symbols of a slot.
		• Spans do not overlap. Every span is contained in a single slot. The same span pattern repeats in every slot. The separation between consecutive spans within and across slots may be unequal, but the same (X, Y) limit must be satisfied by all spans.
		• Every monitoring occasion is fully contained in one span. To determine a suitable span pattern, first a bitmap b(l), 0<=l<=13 is generated, where b(l)=1 if symbol l of any slot is part of a monitoring occasion, b(l)=0 otherwise.
		- The first span in the span pattern begins at the smallest l for which b(l)=1.
		- The next span in the span pattern begins at the smallest l not included in the previous span(s) for which b(l)=1.
			pdcch-MonitoringAnyOccasionsWithSpanGap
			
			(X, Y):
			set1 = (7, 3);
			set2 = (4, 3) and (7, 3);
			set3 = (2, 2) and (4, 3) and (7, 3).
				FeatureSetDownlink-v1540

Index	Feature Group	Components	Field Name*	Parent IE*
		- The span duration is max{maximum value of all CORESET durations, minimum value of Y in the UE reported candidate value} except possibly the last span in a slot which can be of shorter duration. - A particular PDCCH monitoring configuration meets the UE capability limitation if the span arrangement satisfies the gap separation for at least one (X, Y) in the UE reported candidate value set in every slot, including cross slot boundary. • For the set of monitoring occasions which are within the same span: - Processing **one** unicast DCI scheduling DL and **one** unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for FDD - Processing **one** unicast DCI scheduling DL and **two** unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD - Processing **two** unicast DCI scheduling DL and **one** unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD • The number of different start symbol indices of spans for all PDCCH monitoring occasions per slot, including PDCCH monitoring occasions of FG-3-1, is no more than floor(14/X) (X is minimum among values reported by UE). • The number of different start symbol indices of PDCCH monitoring occasions per slot, including PDCCH monitoring occasions of FG-3-1, is no more than 7. • The number of different start symbol indices of PDCCH monitoring occasions per half-slot, including PDCCH monitoring occasions of FG-3-1, is no more than 4 in SCell.		

Notes:
* Field Name and Parent IE from 3GPP TS 38.331 [2].
† This capability is necessary for each SCS.

Table A.1-3: Layer-1 Feature List–UL Configured Grant

Index	Feature Group	Components	Field Name*	Parent IE*
5-19	Type 1 Configured UL grant	K = 1	*configuredUL-GrantType1*	*Phy-ParametersCommon*
5-20	Type 2 Configured UL grant	K = 1	*configuredUL-GrantType2*	*Phy-ParametersCommon*

Note:
* Field Name and Parent IE from 3GPP TS 38.331 [2].

Table A.1-4: Layer-1 Feature List– DL Semi-Persistent Scheduling

Index	Feature Group	Components	Field Name*	Parent IE*
5-18	DL SPS	DL SPS	*downlinkSPS*	*Phy-ParametersCommon*

Note:
* Field Name and Parent IE from 3GPP TS 38.331 [2].

Table A.1-5: Layer-1 Feature List–HARQ-ACK

Index	Feature Group	Components	Field Name*	Parent IE*
4-28	HARQ-ACK multiplexing on PUSCH with different PUCCH/PUSCH starting OFDM symbols	HARQ-ACK piggyback on a PUSCH with/without aperiodic CSI once per slot when the starting OFDM symbol of the PUSCH is different from the starting OFDM symbols of the PUCCH resource that HARQ-ACK would have been transmitted on	*Phy-ParametersFRX-Diff*	No

Notes:
* Field Name and Parent IE from 3GPP TS 38.331 [2].
† Mandatory with capability signalling.
‡ mux-HARQ-ACK-PUSCH-DiffSymbol is a prerequisite feature group for this Index.

Table A.1-6: Layer-1 Feature List– Pre-emption Indication

Index	Feature Group	Components	Field Name*	Parent IE*
5-21	Pre-emption indication for DL	Pre-emption indication for DL	*pre-EmptIndication-DL*	*Phy-ParametersCommon*

Note:

* Field Name and Parent IE from 3GPP TS 38.331 [2].

Table A.1-7: Layer-1 Feature List–Mini-slot

Index	Feature Group	Components	Field Name*	Parent IE*
5-6	PDSCH mapping type A with less than 7 OFDM symbols	PDSCH mapping type A	*pdsch-MappingTypeA*	*Phy-ParametersCommon*
5-6a	PDSCH mapping type B	PDSCH mapping type B	*pdsch-MappingTypeB*	*Phy-ParametersCommon*
5-11	Up to 2 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 1†	• Up to 2 unicast PDSCHs per slot per CC only in TDM is supported for Capability 1 • PDSCH(s) for Msg. 4 is included	*pdsch-ProcessingType1-DifferentTB-PerSlot*	*FeatureSetDownlink*
5-11a	Up to 7 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 1†	• Up to 7 unicast PDSCHs per slot per CC only in TDM is supported for Capability 1 • PDSCH(s) for Msg. 4 is included	*pucch-F2-WithFH*	*Phy-ParametersFRX-Diff*
5-11b	Up to 4 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 1†	• Up to 4 unicast PDSCHs per slot per CC only in TDM is supported for Capability 1 • PDSCH(s) for Msg. 4 is included	*pucch-F3-WithFH*	*Phy-ParametersFRX-Diff*
5-12	Up to 2 PUSCHs per slot per CC for different TBs for UE processing time Capability 1†	Up to 2 unicast PUSCHs per slot per CC only in TDM is supported for Capability 1	*pusch-ProcessingType1-DifferentTB-PerSlot*	*FeatureSetUplink*
5-12a	Up to 7 PUSCHs per slot per CC for different TBs for UE processing time Capability 1†	Up to 7 unicast PUSCHs per slot per CC only in TDM is supported for Capability 1	*freqHoppingPUCCH-F0-2*	*Phy-ParametersFRX-Diff*

Index	Feature Group	Components	Field Name*	Parent IE*
5-12b	Up to 4 PUSCHs per slot per CC for different TBs for UE processing time Capability 1†	Up to 4 unicast PUSCHs per slot per CC only in TDM is supported for Capability 1	*freqHoppingPUCCH-F1-3-4*	*Phy-ParametersFRX-Diff*

Notes:
* Field Name and Parent IE from 3GPP TS 38.331 [2].
† This capability is necessary for each SCS.

Table A.1-8: Layer-1 Feature List–UE Processing Capability 2

Index	Feature Group	Components	Field Name*	Parent IE*
5-5a†	UE PDSCH processing Capability 2	• UE can report values 'X' and 'Fallback', and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X DL CCs, the UE may expect to be scheduled with up to 1 PDSCHs per slot with Capability 2 on all configured serving cells for which processingType2Enabled is configured and set to enabled, otherwise - If Fallback = 'SC', UE supports Capability 2 processing time on lowest cell index among the configured carriers in the band where the value is reported - If Fallback = 'Cap1-only', UE supports only Capability 1, in the band where the value is reported • No scheduling limitation • N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz	*pdsch-ProcessingType2*	*FeatureSetDownlink-v1540*
5-13†, ‡	Up to 2 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 2	• Up to 2 unicast PDSCHs per slot per CC only in TDM is supported for Capability 2 • UE can report values 'X' and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X DL CCs, the UE may expect to be scheduled with up to 2 PDSCHs per slot with Capability 2 on all configured serving cells for which processingType2Enabled is configured and set to enabled	*pdsch-ProcessingType2*	*FeatureSetDownlink*

Index	Feature Group	Components	Field Name*	Parent IE*
		• No scheduling limitation • N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz		
5-13a†, ‡	Up to 7 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 2	• Up to 7 unicast PDSCHs per slot per CC only in TDM is supported for Capability 2 • UE can report values 'X' and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X DL CCs, the UE may expect to be scheduled with up to 7 PDSCHs per slot with Capability 2 on all configured serving cells for which processingType2Enabled is configured and set to enabled • No scheduling limitation • N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz		
5-13c† ‡	Up to 4 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 2	• Up to 4 unicast PDSCHs per slot per CC only in TDM is supported for Capability 2 • UE can report values 'X' and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X DL CCs, the UE may expect to be scheduled with up to 4 PDSCHs per slot with Capability 2 on all configured serving cells for which processingType2Enabled is configured and set to enabled • No scheduling limitation • N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz		
5-5c†	UE PUSCH processing Capability 2	• UE can report values 'X' and 'Fallback', and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X UL CCs, the UE may expect to be scheduled with up to 1 PUSCHs per slot with Capability 2 on all configured serving cells for which	*pusch-ProcessingType2*	*FeatureSetUplink-v1540*

Index	Feature Group	Components	Field Name*	Parent IE*
		processingType2Enabled is configured and set to enabled, otherwise - If Fallback = 'SC', UE supports Capability 2 processing time on lowest cell index among the configured carriers in the band where the value is reported - If Fallback = 'Cap1-only', UE supports only Capability 1, in the band where the value is reported • N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz		
5-13d†, §	Up to 2 PUSCHs per slot per CC for different TBs for UE processing time Capability 2	• Up to 2 unicast PUSCHs per slot per CC only in TDM is supported for Capability 2 • UE can report values 'X' and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X UL CCs, the UE may expect to be scheduled with up to 2 PUSCHs per slot with Capability 2 on all configured serving cells for which processingType2Enabled is configured and set to enabled • N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz	*pusch-ProcessingType2*	*FeatureSetUplink*
5-13e†, §	Up to 7 PUSCHs per slot per CC for different TBs for UE processing time Capability 2	• Up to 7 unicast PUSCHs per slot per CC only in TDM is supported for Capability 2 • UE can report values 'X' and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X UL CCs, the UE may expect to be scheduled with up to 7 PUSCHs per slot with Capability 2 on all configured serving cells for which processingType2Enabled is configured and set to enabled • N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz		
5-13f†, §	Up to 4 PUSCHs per slot per CC for different TBs for UE processing time Capability 2	• Up to 4 unicast PUSCHs per slot per CC only in TDM is supported for Capability 2		

Index	Feature Group	Components	Field Name*	Parent IE*
		• UE can report values 'X' and supports the following operation, only when all carriers are self-scheduled and all Capability 2 carriers in a band are of the same numerology: - When configured with less than or equal to X UL CCs, the UE may expect to be scheduled with up to 4 PUSCHs per slot with Capability 2 on all configured serving cells for which processingType2Enabled is configured and set to enabled • N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz		

Notes:
* Field Name and Parent IE from 3GPP TS 38.331 [2].
† This capability is necessary for each SCS (15kHz, 30kHz, 60kHz). More than one set of per SCS per band reports can be signalled for a given band combination.
‡ Index 5-5a is a prerequisite feature group for Index 5-13, 5-13a, and 5-13c.
§ Index 5-5c is a prerequisite feature group for Index 5-13d, 5-13e, and 5-13f.

Table A.1-9: Layer-1 Feature List–Repetitions

Index	Feature Group	Components	Field Name*	Parent IE*
5-14	Type 1 configured PUSCH repetitions over multiple slots	K = 2, 4, 8 times repetitions with RV sequences	*type1-PUSCH-RepetitionMultiSlots*	*Phy-ParametersCommon*
5-16	Type 2 configured PUSCH repetitions over multiple slots	K = 2, 4, 8 times repetitions with RV sequences	*type2-PUSCH-RepetitionMultiSlots*	*Phy-ParametersCommon*
5-17	PUSCH repetitions over multiple slots	K = 2, 4, 8 times repetitions	*pusch-RepetitionMultiSlots*	*Phy-ParametersCommon*
5-17a	PDSCH repetitions over multiple slots	K = 2, 4, 8 times repetitions	*pdsch-RepetitionMultiSlots*	*Phy-ParametersCommon*

Note:
* Field Name and Parent IE from 3GPP TS 38.331 [2].

A.2 Layer-2 UE features

Table A.2-1 provides the Layer-2 feature included in SFCs, as shown in [1] and the corresponding UE capability field name, as specified in TS 38.331 [2].

Table A.2-1: Layer-2 Feature List–PDCP Duplication

Index	Feature Group	Components	Field Name*	Parent IE*
1-6	PDCP duplication	• PDCP duplication for split SRB1/2 • PDCP duplication for SRB1/2 and/or SRB3 • PDCP duplication for MCG or SCG DRB • PDCP duplication for split DRB	1) *pdcp-DuplicationSplitSRB* 2) *pdcp-DuplicationSRB* 3) *pdcp-DuplicationMCG-OrSCG-DRB* 4) *pdcp-DuplicationSplitDRB*	1), 4) *PDCP-ParametersMRDC* 2), 3) *PDCP-Parameters*

Note:
* Field Name and Parent IE from 3GPP TS 38.331 [2].

Table A.2-2: Layer-2 Feature List–Skipping UL Transmission

Index	Feature Group	Components	Field name in TS 38.331 [2]	Parent IE in TS 38.331 [2]
3-6	Skipping UL transmission	• Skipping UL transmission for dynamic UL grant • Skipping UL transmission for configured UL grant	1) *skipUplinkTxDynamic*	*MAC-ParametersXDD-Diff*

Annex B:
Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2022-04-12						First version	1.0.0