**3GPP TSG RAN WG1 #113 R1-230nnnn**

**Incheon, Korea, May 22nd – May 26th, 2023**

**Agenda item:** 9.16.16

**Source:** Moderator (NTT DOCOMO, INC.)

**Title:** [draft] Summary on UE features for TEIs

**Document for:** Discussion and Decision

# **Introduction**

This document summarizes contributions submitted to AI 9.16.16 regarding UE features for TEIs.

According to the initial UE features list from endorsed TEI proponent [1], there are following feature groups for TEI18.

* FGs for single DCI scheduling multiple PUSCHs for FR1
	+ 55-3 Multiple PUSCHs scheduling by single DCI for non-consecutive slots in FR1

# **FGs for single DCI scheduling multiple PUSCHs for FR1**

In [1], FGs for NR support for dedicated spectrum less than 5MHz for FR1 are captured as below.

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 55. TEI18 | 55-3 | Multiple PUSCHs scheduling by single DCI for non-consecutive slots in FR1 | 1. Multi-PUSCH scheduling by single DCI format 0\_1 for the operation with non-contiguous allocation  | N/A | Yes | N/A | For operation on FR1, scheduling multiple PUSCHs by a DCI format 0\_1 in non-contiguous slots is not supported. | Per Band | No | Yes | N/A |  | Optional with capability signalling |

Following inputs are provided in contributions for the RAN1#113 meeting.

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| [2] | Nokia, Nokia Shanghai Bell | RAN1#112bis agreed on the following for TEI18

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| **Agreement**Introduce UE feature(s) for multi-PUSCH scheduling with single DCI 0\_1 for non-contiguous slots in FR1 for all defined SCSs* Note: there is no RAN1 impact
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The corresponding Rel-17 capabilities extending the feature to FR2\_1 and FR2\_2

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** |  | **Consequence if the feature is not supported by the UE** | **Type** **(...)** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 24. NR\_ext\_to\_71GHz | 24-1e | Multiple PUSCH scheduling by single DCI for 120kHz in FR2-2 | 1. Multi-PUSCH scheduling by single DCI for the operation with 120 kHz SCS | 24-1a | Yes |  | Multiple PUSCH scheduling by single DCI for 120kHz is not supported in FR2-2 | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
|  24. NR\_ext\_to\_71GHz | 24-1g | Multiple PUSCH scheduling by single DCI for 120kHz in FR2-1 | 1. Multi-PUSCH scheduling by single DCI for the operation with 120 kHz SCS with non-contiguous allocation  |  | Yes |  | Multiple PUSCH scheduling by single DCI for 120kHz is not supported in FR2-1 with non-contiguous allocation | Per band | N/A | N/A | N/A |  | Optional with capability signalling |

The new capability extending this to FR1 would be straightforward:

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** |  | **Consequence if the feature is not supported by the UE** | **Type** **(...)** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 55TEI18 | 55-x | Multiple PUSCH scheduling by single DCI in FR1 | 1. Multi-PUSCH scheduling by single DCI for FR1 with non-contiguous allocation  |  | Yes |  | Multiple PUSCH scheduling by single DCI is not supported on FR1 with non-contiguous allocation | Per band | N/A | N/A | N/A |  | Optional with capability signalling |

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| [3] | Huawei, HiSilicon | In **Rel-16 NR-U**, according to TR38.822 [2], the UE feature group for contiguous multi-PUSCH scheduling with single DCI 0\_1 was introduced for all SCSs for a shared spectrum operation, in order to avoid unnecessary LBT attempts before individual PUSCHs are due to receive UL grants in DL.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Type** | **Mandatory/Optional** |
| 10-17 | Multi-PUSCH UL grant | 1. Support of scheduling up to 8 PUSCH with a single DCI 0\_1  |  | Per band | Optional with capability signalling |

When this feature group was captured in TS38.306 [3], the restriction to apply this on only the unlicensed band was removed. It was also extended to FR2-1 for all SCS.

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| **Definitions for parameters** | **Per** | **M** | **FDD-TDD DIFF** | **FR1-FR2 DIFF** |
| ***multiPUSCH-UL-grant-r16***Indicates whether the UE supports scheduling up to 8 PUSCH with a single DCI 0\_1. This capability is also applicable to a frequency band that does not require shared spectrum access. | Band | No | N/A | N/A |

In **Rel-17 FR2-2**, the feature for non-contiguous multi-PUSCH scheduling with single DCI 0\_1 was designed based on its contiguous version for 480kHz and 960kHz SCS in order to reduce the PDCCH BD within the unit time. They were included as a component of the FG for basic support of 480kHz and 960kHz SCS for UL.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Type** | **Mandatory/Optional** |
| 24-4a | 480KHz SCS support for UL | 1. PRACH with 480KHz and length 1392. 480KHz SCS for UL data and control channels and reference signal transmission in FR2-23. Multi-PUSCH scheduling by single DCI for the operation with 480 kHz SCS | 24-1a, 24-4 | Per band | Optional with capability signalling |
| 24-5a | 960KHz SCS support for UL | 1. PRACH with 960KHz and length 1392. 960KHz SCS for UL data and control channels and reference signal transmission in FR2-23. Multi-PUSCH scheduling by single DCI for the operation with 960 kHz SCS | 24-1a, 24-5 | Per band | Optional with capability signalling |

It was further extended to 120kHz SCS for FR2-2 and FR2-1 during the UE features discussions.

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| 24-1e | Multiple PUSCH scheduling by single DCI for 120kHz in FR2-2 | 1. Multi-PUSCH scheduling by single DCI for the operation with 120 kHz SCS | 24-1a | Per band | Optional with capability signalling |
| 24-1g | Multiple PUSCH scheduling by single DCI for 120kHz in FR2-1 | 1. Multi-PUSCH scheduling by single DCI for the operation with 120 kHz SCS with non-contiguous allocation  |  | Per band | Optional with capability signalling |

The FG24-1g is captured in TS38.306 [3] as follows:

| **Definitions for parameters** | **Per** | **M** | **FDD-TDD DIFF** | **FR1-FR2 DIFF** |
| --- | --- | --- | --- | --- |
| ***multiPUSCH-SingleDCI-FR2-1-SCS-120kHz-r17***Indicates whether the UE supports multi-PUSCH scheduling by single DCI for the operation with 120kHz SCS in FR2-1 with non-contiguous allocation. | Band | No | N/A | N/A |

In order to support non-contiguous multi-PUSCH scheduling with single DCI 0-1 in FR1 for all SCSs, FG 24-1g can be taken as reference. Considering the non-contiguous version is enhanced based on the contiguous version, FG10-17 can be the requisite for the new FG. Accordingly, we propose that the following FG can be introduced:

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| **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Consequence if the feature is not supported by the UE** | **Type** | **Need of FR1/FR2 differentiation** | **Mandatory/Optional** |
| Enhanced Multi-PUSCH UL grant in FR1. | 1.Multi-PUSCH scheduling by single DCI with non-contiguous allocation for all SCS in FR1  | 10-17 | Yes | Non-contiguous multi-PUSCH scheduling is not supported in FR1 | per band | FR1 only | Optional with capability signalling |

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## **Discussion**

**Proposal 2-1:**

* + **Introduce FG55-3 for multiple PUSCHs scheduling by single DCI for non-consecutive slots in FR1**

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| 55. TEI18 | 55-3 | Multiple PUSCHs scheduling by single DCI for non-consecutive slots in FR1 | 1. Multi-PUSCH scheduling by single DCI format 0\_1 for the operation with non-contiguous allocation  | [10-17] | Yes | N/A | For operation on FR1, scheduling multiple PUSCHs by a DCI format 0\_1 in non-contiguous slots is not supported. | Per Band | N/A | N/A | N/A |  | Optional with capability signalling |

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| Company | Comment |
| Moderator | Companies are generally fine to introduce FG 55-2, while companies have different view on whether FG 10-17 is added as the prerequisite FG. Companies are also invited to provide view on this aspect. |
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# **Conclusions**

To be updated

# **References**

[1] R1-2304416 UE feature for endorsed TEI-18 on single DCI scheduling multiple PUSCHs Ericsson, Qualcomm

[2] R1-2305729 On UE features for TEI-18 Nokia, Nokia Shanghai Bell

[3] R1-2305945 UE feature for non-contiguous multi-PUSCH scheduling with single DCI 0\_1 in FR1 Huawei, HiSilicon