**3GPP TSG RAN WG1 #100bis-e R1-20xxxxx**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-01]

Agenda Item: 7.2.11.5

**Document for:** **Discussion and Decision**

# **Introduction**

This contribution summarizes the following email discussion in AI 7.2.11.5 regarding UE features for URLLC/IIoT.

[100b-e-NR-UEFeatures-URLLC/IIoT-01] Email discussion/approval on the feature groups structure related to PDCCH enhancements for URLLC (20th-24th April) – Hiroki (DCM)

* Confirm to keep 11-1/1a/2/2b
* Discuss following on 11-1a
	+ Whether or not to introduce separate capabilities for DL and UL DCI format
* Discuss following on 11-2b
	+ Confirm to introduce separate capabilities for support of mixed Rel-16 PDCCH monitoring capability and Rel-15 PDCCH monitoring capability on different serving cells.
	+ Whether to introduce separate capabilities for mixed Rel-16 capability with Rel-15 PDCCH monitoring capability FG 3-1, FG 3-2, FG 3-5b on different serving cells.
		- If the separate capabilities are introduced,
			* Candidate values for capability on number of CCs with FG 3-1, FG3-2, and FG3-5b

# **11-1: Monitoring DCI format 1\_2 and DCI format 0\_2**

In [1], FG11-1 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 (V2X 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 |
| 11. NR\_L1enh\_URLLC | 11-1 | Monitoring DCI format 1\_2 and DCI format 0\_2 | 1) Supports monitoring DCI format 1\_2 for DL scheduling 2) Supports monitoring DCI format 0\_2 for UL scheduling  |  | Yes | N/A |  | Per UE | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2]  |  | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [15] | Qualcomm | FDD/TDD and FR1/FR2 differentiation should be “Yes”

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-1 | Monitoring DCI format 1\_2 and DCI format 0\_2 | 1) Supports monitoring DCI format 1\_2 for DL scheduling 2) Supports monitoring DCI format 0\_2 for UL scheduling  |  | Yes | N/A |  | Per UE | Yes | Yes | The differentiation is from the perspective of the scheduling cell |  | Optional with capability signalling |

 |
| [16] | Huawei, HiSilicon | Not necessary to do differentiation for FDD/TDD and FR1/FR2. The capability on this FG 11-1 can be reported in the granularity of per UE. |

## 2.1 Discussion 1

**The proposal is to confirm that FG11-1 is kept.**

**Companies are encouraged to provide views if there is a concern or comment on the proposal.**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | It is OK to keep it. |
| Qualcomm | Separate FGs for DL and UL as the features to be supported by the UE are significantly different in the two directions. |
| Huawei/HiSilicon | We don’t see the necessity to split this row into two and also if we split I think it is not aligned with the current agreements. According to agreed RRC parameter below and the endorsed specifications, you could see that DCI format 0\_1/1\_1/0\_2/1\_2 is configured together.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| dci-Formats-Rel16  | New | dci-Formats-Rel16  | Indicates whether the UE monitors in this USS for new DCI formats for DL and UL scheduling in Rel-16 | {formats0-0-And-1-0, formats0-1-And-1-1, formats0-2-And-1-2, formats0-1-And-1-1-And-0-2-And-1-2} |

 |
| DOCOMO | Support to keep it. It is aligned with the current RRC parameter presented by HW. |
| Ericsson | Support to keep this FG. Do not support to split it for DL and UL. The RRC parameter is shown below. dci-FormatsExt-r16 ENUMERATED {formats0-1-And-1-1, formats0-2-And-1-2, formats0-1-And-1-1And-0-2-And-1-2} |
| Intel | Agree to keep FG 11-1. No reason to split DL and UL. |
| MediaTek | Support to keep this FG. |

# **11-1a: Monitoring both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 in the same search space**

In [1], FG11-1a is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 (V2X 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 |
| 11. NR\_L1enh\_URLLC | 11-1a | Monitoring both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 in the same search space  | 1) Supports monitoring both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 in the same search space  | 11-1 | Yes | N/A |  | Per UE | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2 ] | FFS: Whether to split 11-1a into two rows as below:11-1a: DCI format 1\_2 with DCI format 1\_1 in the same search space11-1b: DCI format 0\_2 with DCI format 0\_1 in the same search space | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [3] | vivo | * Regarding FFS, no need to split FG11-1a into two capabilities for DL DCI format and UL DCI format.
	+ Current RRC configuration of search space is given as {formats0-0-And-1-0, formats0-1-And-1-1, formats0-2-And-1-2, formats0-1-And-1-1-And-0-2-And-1-2} so the DCI format 1\_2 and 0\_2 are always configured together. If the feature group split is to be done, there seems a need to change RRC configuration as well.
 |
| [8] | LGE | * Regarding FFS, no need to split FG11-1a into two capabilities for DL DCI format and UL DCI format.
	+ There is no case where a UE is configured to monitor DCI format 1\_1(1\_2) but not DCI format 0\_1(0\_2) for a given search space set.
 |
| [10] | CATT | * Regarding FFS, no need to split FG11-1a into two capabilities for DL DCI format and UL DCI format.
	+ A UE is always capable to detect both DCI format 0\_1 and DCI format 1\_1 in the same search space which is a mandatory capability.
	+ DCI format 0\_1 and DCI format 1\_1 have to be configured simultaneously in a search space, so do DCI format 0\_2 and DCI format 1\_2.
 |
| [11] | Samsung | * Regarding FFS, no need to split FG11-1a into two capabilities for DL DCI format and UL DCI format.
	+ Given that DCI formats 0\_2 and 1\_2 can have a same size, a split of the DCI formats into two search space sets as in the FFS is actually counterproductive.
 |
| [14] | Nokia, NSB | * Regarding FFS, no need to split FG11-1a into two capabilities for DL DCI format and UL DCI format.
 |
| [15] | Qualcomm | * Regarding FFS, split FG11-1a into two capabilities for UL DCI format and DL DCI format i.e. FG11-1a and FG11-1b, respectively.
* FDD/TDD and FR1/FR2 differentiation should be “Yes”

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-1a | Monitoring both DCI format 0\_1/0\_2 in the same search space  | Supports monitoring both DCI format 0\_1/0\_2in the same search space  | 11-1 | Yes | N/A |  | Per UE | Yes | Yes | The differentiation is from the perspective of the scheduling cell |  | Optional with capability signalling |
| 11-1b | Monitoring both DCI format 1\_2 and 1\_1 in the same search space | Supports monitoring both DCI format 1\_2/1\_1 in the same search space | 11-1 | Yes | N/A |  | Per UE | Yes | Yes | differentiation is from the perspective of the scheduling cell |  | Optional with capability signaling  |

 |
| [16] | Huawei, HiSilicon | * Regarding FFS, no need to split FG11-1a into two capabilities for DL DCI format and UL DCI format.
* Not necessary to do differentiation for FDD/TDD and FR1/FR2. The capability on this FG 11-1 can be reported in the granularity of per UE.
 |

## 3.1 Discussion 2

**The proposal is to confirm that FG11-1a is kept.**

**Companies are encouraged to provide views if there is a concern or comment on the proposal.**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | It is OK to keep it. |
| Qualcomm | The same as for 11-1, we propose to separate this FG: one for DL and one for UL. |
| Huawei/HiSilicon | Agree with the proposal with similar reason given above for FG 11-1. |
| DOCOMO | Support to keep it. It is aligned with the current RRC parameter presented by HW in Discussion 1. |
| Ericsson | Support to keep this FG. Do not support to split it for DL and UL. The RRC parameter is shown below. dci-FormatsExt-r16 ENUMERATED {formats0-1-And-1-1, formats0-2-And-1-2, formats0-1-And-1-1And-0-2-And-1-2}  |
| Intel | Agree to keep FG 11-1a. No need to split DL and UL. |
| MediaTek | Support to keep this FG. |

## 3.2 Discussion 3

**Companies are encouraged to provide views on whether or not to introduce separate capabilities for DL and UL DCI format.**

 **Introducing separate capabilities supported by:**

 **Objected (i.e., keeping it as single FG) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | We still do not see a need to separate them, hence we propose to confirm the proposal from the UE features session, i.e. do not split the FG in DL and UL.  |
| Qualcomm | Separate FGs for DL and UL as the features to be supported by the UE are significantly different in the two directions. |
| Huawei/HiSilicon | Share similar view as Nokia, we still don’t see strong motivation on the splitting. In addition, the reason given for FG 11-1 is valid here also.  |
| DOCOMO | Share the same view as Nokia and HW, while we are open to see the motivation further. |
| Apple | We would prefer to introduce separate capabilities for DL and UL DCI formats for 11-1 and 11-1a but can relax our objection in the interest of progress. |
| Ericsson | Do not support to introduce separate capabilities for DL and UL DCI format. As can be seen from the RRC parameter below, DL and UL DCI formats are always paired. dci-FormatsExt-r16 ENUMERATED {formats0-1-And-1-1, formats0-2-And-1-2, formats0-1-And-1-1And-0-2-And-1-2} |
| Intel | No need to split DL and UL. |
| MediaTek | We don’t support to introduce separate capabilities for DL and UL DCI format. |

In Monday UE features session, following proposal was discussed.

**Proposal:**

FG11-1/1a are not split for DL and UL

 Supported by: Nokia, MediaTek, DOCOMO, ZTE, Panasonic, Intel, Huawei, LGE, Ericsson, vivo

 Objected by: Apple, Qualcomm

# **11-2: Rel-16 PDCCH monitoring capability**

In [1], FG11-2 is 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 (V2X 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 |
| 11. NR\_L1enh\_URLLC | 11-2 | Rel-16 PDCCH monitoring capability  | 1) Supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span for combination (X, Y, μ) 2) If UE reports the support of more than one combination of C(X, Y) for a given SCS, and if multiple combinations of C(X, Y) are valid for the span pattern, the maximum value of C of the valid combinations is applied3) Supports the limit M on the maximum number of monitored PDCCH candidates per PDCCH monitoring span for combination (X, Y, μ) 4) If UE reports the support of more than one combination of M(X, Y) for a given SCS, and if multiple combinations of M(X, Y) are valid for the span pattern, the maximum value of M of the valid combinations is applied5) Capability on the number of CCs with Rel-16 PDCCH monitoring capability on all the serving cells.  | 3-5b  | Yes | N/A |  | [FSPC]FFS: Compoent 5) reported per UE | [N/A] | [N/A] |  | This capability is necessary for SCS 15 kHz and 30 kHz. FFS: Adding a component for “supported combination(s) (X, Y, μ), which may depend on how to report C, M and (X, Y, μ) A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #1;A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #2;For component 5), if UE supports carrier aggregation with more than [x] DL carriers with Rel-16 PDCCH monitoring capability on all the carriers, UE should report this capability. Value of x (can be < 4) is TBD.FFS: Whether to merge component 1) and 3), and accordingly merge component 2) and 4)FFS：Whether to add a capability for supporting 3 unicast PDSCH/PUSCH per slot separately for each minimum processing capability to match the number of spans for (4,3) pair | Optional with capability signallingCandidate value set for (X, Y):{(7, 3), (4, 3), (2, 2)}The value of C for combination (7, 3) for 15 kHz and 30 kHz is 56FFS the value of C for combination (4, 3) and (2, 2)FFS the value of M for combination (7, 3), (4, 3) and (2, 2)Candidate value for component 5): { x, x+1, …, 16} |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | ZTE | * For reporting type, component 5) is reported per UE, while other components are reported per FS.
* For the FFS points in the note column,
* No need to add a component for “supported combination(s) (X, Y, μ)’ now. It can be further discussed after the values of C and M are decided in URLLC agenda. If the value is the same for different SCS, there is no need to add such component.
* Merge component 1) and 3), and accordingly merge component 2) and 4).
* No need to add a capability for supporting 3 unicast PDSCH/PUSCH per slot, which is not even reported by a Rel-15 eMBB UE.
* The values of C, M, x can be further updated once determined in URLLC agenda.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 11-2 | Rel-16 PDCCH monitoring capability  | 1) Supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span for combination (X, Y, μ) 2) If UE reports the support of more than one combination of C(X, Y) for a given SCS, and if multiple combinations of C(X, Y) are valid for the span pattern, the maximum value of C of the valid combinations is applied3) Supports the limit M on the maximum number of monitored PDCCH candidates per PDCCH monitoring span for combination (X, Y, μ) 4) If UE reports the support of more than one combination of M(X, Y) for a given SCS, and if multiple combinations of M(X, Y) are valid for the span pattern, the maximum value of M of the valid combinations is applied5) Capability on the number of CCs with Rel-16 PDCCH monitoring capability on all the serving cells.  | ~~[FSPC]~~ FS~~FFS:~~ Component 5) reported per UE | This capability is necessary for SCS 15 kHz and 30 kHz. FFS: Adding a component for “supported combination(s) (X, Y, μ), which may depend on how to report C, M and (X, Y, μ) A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #1;A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #2;For component 5), if UE supports carrier aggregation with more than [x] DL carriers with Rel-16 PDCCH monitoring capability on all the carriers, UE should report this capability. Value of x (can be < 4) is TBD.~~FFS: Whether to merge component 1) and 3), and accordingly merge component 2) and 4)~~~~FFS：Whether to add a capability for supporting 3 unicast PDSCH/PUSCH per slot separately for each minimum processing capability to match the number of spans for (4,3) pair~~ | Optional with capability signallingCandidate value set for (X, Y):{(7, 3), (4, 3), (2, 2)}The value of C for combination (7, 3) for 15 kHz and 30 kHz is 56FFS the value of C for combination (4, 3) and (2, 2)FFS the value of M for combination (7, 3), (4, 3) and (2, 2)Candidate value for component 5): { x, x+1, …, 16} |

 |
| [3] | vivo | * Regarding the FFS “FFS: Whether to merge component 1) and 3), and accordingly merge component 2) and 4),” it seems not beneficial according to the previous discussion, the increased CCE processing capability is more essential than BD in URLLC operation with per span monitoring.
* Regarding the FFS “FFS：Whether to add a capability for supporting 3 unicast PDSCH/PUSCH per slot separately for each minimum processing capability to match the number of spans for (4,3) pair,” it is reasonable to add such capability in order to match the monitoring span pattern of (4,3). Furthermore, we need to further consider to add separate capabilities for PDSCH and PUSCH respectively, similar as in Rel-15
* Regarding the type [FSPC] of 11-2, we agree with using FSPC to allow UE reporting different span patterns for different CC.
 |
| [4] | OPPO | For FG 11-2, this feature group is defined per UE. |
| [7] | Media Tek Inc. | For FG11-2, add a new component to indicate if the UE can support non-aligned spans for the case when the UE is configured with$ \sum\_{μ=0}^{1}N\_{cells,r16}^{DL,μ}>N\_{cells}^{cap-r16}$.　　　　　Figure 1: Aligned spans on 2 CCs.　　　　　　　　　　Figure 2: Non-aligned spans on 2 CCs. |
| [8] | LGE | * Regarding the FFS “FFS: Whether to merge component 1) and 3), and accordingly merge component 2) and 4),” it seems not beneficial according to the previous discussion, the increased CCE processing capability is more essential than BD in URLLC operation with per span monitoring.
	+ This should be decided after the value of M and C for each span combination is decided.
* For another FFS point on 3 PDSCH/PUSCH per slot, it would be necessary for efficient scheduling under (4, 3) pair.
 |
| [10] | CATT | * There is no reason to define separate UE capability C(X,Y,μ)/m(X,Y,μ) for different processing capability.
* Considering that FG 5-12 series and FG 5-13 series have already defined the maximum number of PUSCH and PDSCH per slot respectively, it is not necessary to add a capability for supporting 3 unicast PDSCH/PUSCH per slot separately for each minimum processing capability to match the number of spans for (4,3) pair. bbbbb

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-2 | Rel-16 PDCCH monitoring capability  | 1) Supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span for combination (X, Y, μ) 2) If UE reports the support of more than one combination of C(X, Y) for a given SCS, and if multiple combinations of C(X, Y) are valid for the span pattern, the maximum value of C of the valid combinations is applied3) Supports the limit M on the maximum number of monitored PDCCH candidates per PDCCH monitoring span for combination (X, Y, μ) 4) If UE reports the support of more than one combination of M(X, Y) for a given SCS, and if multiple combinations of M(X, Y) are valid for the span pattern, the maximum value of M of the valid combinations is applied5) Capability on the number of CCs with Rel-16 PDCCH monitoring capability on all the serving cells.  | 3-5b  | Yes | N/A |  | [FSPC]FFS: Compoent 5) reported per UE | [N/A] | [N/A] |  | This capability is necessary for SCS 15 kHz and 30 kHz. FFS: Adding a component for “supported combination(s) (X, Y, μ), which may depend on how to report C, M and (X, Y, μ) ~~A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #1;~~~~A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #2;~~For component 5), if UE supports carrier aggregation with more than [x] DL carriers with Rel-16 PDCCH monitoring capability on all the carriers, UE should report this capability. Value of x (can be < 4) is TBD.FFS: Whether to merge component 1) and 3), and accordingly merge component 2) and 4)~~FFS：Whether to add a capability for supporting 3 unicast PDSCH/PUSCH per slot separately for each minimum processing capability to match the number of spans for (4,3) pair~~ | Optional with capability signallingCandidate value set for (X, Y):{(7, 3), (4, 3), (2, 2)}The value of C for combination (7, 3) for 15 kHz and 30 kHz is 56FFS the value of C for combination (4, 3) and (2, 2)FFS the value of M for combination (7, 3), (4, 3) and (2, 2)Candidate value for component 5): { x, x+1, …, 16} |

 |
| [11] | Samsung | * For 3 unicast PDSCH/PUSCH per slot capability, it is not clear motivation in which (4,3) pair will provide 4 monitoring occasion in slot. It is sufficient to have 1/2/4/7 unicast PDSCH/PUSCH capability in current UE capability.
* For component 5), it will be per UE or per BC.
* No need to merge 1) and 3). There may be a scenario where C needs to increase while M still is same or smaller
 |
| [12] | Apple | * Remove the dependency of FG 11-2 on FG 3-5b as handling is quite different; for 3-5b, the overbooking/dropping is performed on a per-slot basis, while for 11-2, it is performed on a per-span basis.
	+ Logically speaking, there is no reason why a UE has to support 3-5b to be able to support 11-2.
* Regarding the FFS “FFS: Whether to merge component 1) and 3), and accordingly merge component 2) and 4),”
	+ It makes sense to merge component 1) and 3) in 11-2, because C and M need to report together for each supported combination (X, Y, μ). Combining them avoid the possibility that a UE report C but not M (or vice versa) for one (X, Y, μ) combination.
	+ Whether to merge 2) and 4) is less critical because there is no separate signaling for these two, and both will be supported if a UE reports 11-2.
 |
| [14] | Nokia, NSB | Fine with merging components 1 & 3, and components 2 & 4 |
| [15] | Qualcomm | Following updates are proposed.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-2 | Rel-16 PDCCH monitoring capability  | 1. Supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span and the limit M on the maximum number of BDs per PDCCH monitoring span for combination (X, Y, μ)

2) Supported combinations of (X,Y,u)  3) If UE reports the support of more than one combination of (X, Y) for a given SCS, and if multiple combinations of (X, Y) are valid for the span pattern, the span pattern with the maximum value of C and M from the valid combinations is applied.  4) Capability on the number of CCs with Rel-16 PDCCH monitoring capability on all the serving cells.  |  | Yes | N/A |  | FSPC | N/A | N/A |  | This capability is necessary for SCS 15 kHz and 30 kHz. A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #1;A list of separate UE capabilities C(X, Y, μ), M(X, Y, μ) for processing capability #2;For component 4), if UE supports carrier aggregation with more than [x] DL carriers with Rel-16 PDCCH monitoring capability on all the carriers, UE should report this capability. Value of x is 2. | Optional with capability signallingCandidate value set for (X, Y):{(7, 3), (4, 3), (3,2)(2, 2)}The value of C for combination (7, 3) for 15 kHz and 30 kHz is 56FFS the value of C for combination (4, 3) and (3,2) and (2, 2)FFS the value of M for combination (7, 3), (4, 3) and (3,2) and (2, 2)Candidate value for component 5): { 2, 3, …, 16} |
| 11-2b | Mix of Rel. 16 PDCCH monitoring capability and FG3-2 PDCCH monitoring capability in the same slot in the same CC | 1) Supports PDCCH monitoring operation according to FG3-22) In addition to 1), supports PDCCH monitoring with limit C on the maximum number of additional non-overlapped CCEs for channel estimation per PDCCH monitoring span and with limit M on the maximum number of additional BDs, for a combination (X, Y, μ) 3) Supported combinations of (X, Y, μ)1. 4) If UE reports the support of more than one combination of (X, Y) for a given SCS, and if multiple combinations of (X, Y) are valid for the span pattern, the span pattern with the maximum value of C and M from the valid combinations is applied
 | 11-2, 3-2 | Yes | N/A |  | FSPC | N/A | N/A |  | This capability is necessary for SCS 15kHz and 30 kHz. Component-3 candidate value set: (X, Y) = {(7, 3), (4, 3), (3,2), (2, 2)}The candidate values for capability on the number of CCs with FG3-2 PDCCH monitoring capability are {2,3,…,16} The candidate values for capability on the number of CCs with Rel-16 PDCCH monitoring capability are {1,2,…,16} | Optional with capability signaling  |
| 11-2c | Mix of Rel. 16 PDCCH monitoring capability and FG3-5b PDCCH monitoring capability in the same slot in the same CC | 1) Supports PDCCH monitoring operation according to FG3-5b for combination (X1, Y1, μ)2) In addition to 1), supports PDCCH monitoring with limit C on the maximum number of additional non-overlapped CCEs for channel estimation per PDCCH monitoring span and with limit M on the maximum number of additional BDs, for a combination (X, Y, μ) 3) Supported combinations of (X1, Y1, μ)4) Supported combinations of (X2, Y2, μ)1. 5) If UE reports the support of more than one combination of (X2, Y2) for a given SCS, and if multiple combinations of (X2, Y2) are valid for the span pattern, the span pattern with the maximum value of C and M from the valid combinations is applied
 | 11-2 | Yes | N/A |  | FSPC | N/A | N/A |  | This capability is necessary for SCS 15kHz and 30 kHz. Component-3 candidate value set: (X1, Y1) = {(7, 3), (4, 3) and (7, 3), (2, 2) and (4, 3) and (7, 3)}Component-4 candidate value set: (X2, Y2) = {(7, 3), (4, 3), (3,2), (2, 2)}The candidate values for capability on the number of CCs with FG3-5b PDCCH monitoring capability are {2,3,…,16} The candidate values for capability on the number of CCs with Rel-16 PDCCH monitoring capability are {1,2,…,16} | Optional with capability signaling |

 |

## 4.1 Discussion 4

**The proposal is to confirm that FG11-2 is kept.**

**Companies are encouraged to provide views if there is a concern or comment on the proposal.**

|  |  |
| --- | --- |
| Company | Comment |
|  |  |
|  |  |
|  |  |
|  |  |

In Monday UE features session, following is agreed.

**Agreements**:

FG11-2 is kept.

# **11-2b: Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells**

In [1], FG11-2b is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 (V2X 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 |
| 11. NR\_L1enh\_URLLC | 11-2b | Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells | [Support Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells] 1. Capability on the number of CCs with Rel-15 PDCCH monitoring capability
2. Capability on the number of CCs with Rel-16 PDCCH monitoring capability
 | 11-2 | Yes | N/A |  | [Per UE] | [No] | TBD |  | Capability on the number of CCs with Rel-15 PDCCH monitoring capability can be smaller than 4 CCs; Capability on the number of CCs with Rel-16 PDCCH monitoring capability can be smaller than 4 CCs;The summation of the minimum of the capability on the number of CCs with Rel-15 PDCCH monitoring capability and the minimum of the capability on the number of CCs with Rel-16 PDCCH monitoring capability is not larger than 4 [Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b.] | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | ZTE | As for the open points in bracket, * Based on the discussion after RAN1#100 e-meeting, it is fine to use a separate UE capability for the case with mixed monitoring capabilities. But Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b.
* Similar to the reporting of PDCCH blind detection capability for MCG and for SCG in NR DC (FG 6-25a), capability reporting for this FG can be per UE.
* Not necessary FDD/TDD differentiation. For FR1/FR2 differentiation, it may depend on whether we will support SCS other than 15 kHz and 30 kHz. This can be further updated once there is an agreement in URLLC agenda.

|  |
| --- |
| ***Suggested revision #2 on FG 11-2b*** |
| Index | Feature group | Components | 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 | Note |
| 11-2b | Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells | ~~[~~Support Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells~~]~~ Capability on the number of CCs with Rel-15 PDCCH monitoring capability Capability on the number of CCs with Rel-16 PDCCH monitoring capability | [Per UE~~]~~ | ~~[~~No~~]~~ | TBD | Capability on the number of CCs with Rel-15 PDCCH monitoring capability can be smaller than 4 CCs; Capability on the number of CCs with Rel-16 PDCCH monitoring capability can be smaller than 4 CCs;The summation of the minimum of the capability on the number of CCs with Rel-15 PDCCH monitoring capability and the minimum of the capability on the number of CCs with Rel-16 PDCCH monitoring capability is not larger than 4 ~~[~~Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b.~~]~~ |

 |
| [3] | vivo | Current version of 11-2b is reasonable and the Rel-15 monitoring capability refers to the FG 3-1, FG 3-2 and FG 3-5b as indicated by UE through Rel-15 capability reporting.  |
| [7] | Media Tek Inc. | For FG11-2b, remove the brackets from the following description “*[Support Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells]*”. |
| [8] | LGE | * On FG 11-2b, fine to have separate capability between Rel-16 only (FG 11-2) and mixed capabilities (FG 11-2b).
	+ As pointed out by others, it is possible to configure FG 3-1 for some serving cells and FG 3-5b for other serving cells and no separate capability are defined in Rel-15 to indicate whether particular combinations are supported or not. In this context, even the note ([Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b.]) may not be needed.
 |
| [12] | Apple | * Regarding question “Whether to split 11-2b into 3 FGs, corresponding to 3-1, 3-2, and 3-5b in Rel-15, respectively?,” it would be beneficial
	+ Even though the number of CCs is not separated reported for 3-1, 3-2 and 3-5b in Rel-15, it is generally acknowledged that the three features do not have the same complexity. In particular, 3-5b is more complicated than 3-1/3-2 and requires more UE processing power. By splitting 11-2b into 3 features, it allows the UE to report different capabilities corresponding to different Rel-15 features. For example, the UE may potentially report larger number of CCs for the combination of 3-1 and 11-2 than for the combination of 3-5b and 11-2. Otherwise, the UE would have to report conservatively, i.e., report the number corresponding to the most complicated one among 3-1, 3-2 and 3-5b (if all are supported), which is most likely to be 3-5b.
 |
| [13] | Panasonic | * Support to introduce separate UE capability for support of mixed Rel-16 PDCCH monitoring capability and Rel-15 PDCCH monitoring capability on different serving cells.
* Not to introduce separate capabilities for mixed Rel-16 capability with Rel-15 PDCCH monitoring capability FG 3-1, FG 3-2, FG 3-5b on different serving cells.
 |
| [14] | Nokia, NSB | As noted earlier, UE should be able report more than one valid combination of R15 & R16 carriers to be able to operate the UE efficiently (e.g. 2 or 3 combinations allowed) |
| [15] | Qualcomm | Following updates are proposed.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-2a | Mix of Rel. 16 PDCCH monitoring capability and FG3-1 PDCCH monitoring capability in the same slot  | 1) Supports PDCCH monitoring operation according to FG3-12) In addition to 1), supports PDCCH monitoring with limit C on the maximum number of additional non-overlapped CCEs for channel estimation per PDCCH monitoring span and with limit M on the maximum number of additional BDs, for a combination (X, Y, μ) 3) Supported combinations of (X, Y, μ)4) If UE reports the support of more than one combination of (X, Y) for a given SCS, and if multiple combinations of (X, Y) are valid for the span pattern, the span pattern with the maximum value of C and M from the valid combinations is applied | 11-2 | Yes | N/A |  | FSPC | N/A | N/A |  | This capability is necessary for SCS 15kHz and 30 kHz. Component-3 candidate value set: (X, Y) = {(7, 3), (4, 3), (3,2) (2, 2)}The candidate values for capability on the number of CCs with FG3-1 PDCCH monitoring capability are {2,3,…,16} The candidate values for capability on the number of CCs with Rel-16 PDCCH monitoring capability are {1,2,…,16} | Optional with capability signalling |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11-2b | Mix of Rel. 16 PDCCH monitoring capability and FG3-2 PDCCH monitoring capability in the same slot  | 1) Supports PDCCH monitoring operation according to FG3-22) In addition to 1), supports PDCCH monitoring with limit C on the maximum number of additional non-overlapped CCEs for channel estimation per PDCCH monitoring span and with limit M on the maximum number of additional BDs, for a combination (X, Y, μ) 3) Supported combinations of (X, Y, μ)4) If UE reports the support of more than one combination of (X, Y) for a given SCS, and if multiple combinations of (X, Y) are valid for the span pattern, the span pattern with the maximum value of C and M from the valid combinations is applied | 11-2, 3-2 | Yes | N/A |  | FSPC | N/A | N/A |  | This capability is necessary for SCS 15kHz and 30 kHz. Component-3 candidate value set: (X, Y) = {(7, 3), (4, 3), (3,2), (2, 2)}The candidate values for capability on the number of CCs with FG3-2 PDCCH monitoring capability are {2,3,…,16} The candidate values for capability on the number of CCs with Rel-16 PDCCH monitoring capability are {1,2,…,16} | Optional with capability signaling  |

 |
| [16] | Huawei, HiSilicon | * Not necessary to set separate capabilities for mixed Rel-16 capability with Rel-15 PDCCH monitoring capability FG 3-1, FG 3-2, FG 3-5b on different serving cells

In Rel-15, it seems same *pdcch-BlindDetectionCA* is applied no matter whether FG 3-1 or FG 3-2 or FG 3-5b is configured in Rel-15. If the concern is that FG 3-1, FG 3-2 and FG 3-5b is separate UE capability in Rel-15, it seems the note “*Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b.*” given by the rapporteur is sufficient.  |

## 5.1 Discussion 5

**The proposal is to confirm that FG11-2b is kept.**

**Companies are encouraged to provide views if there is a concern or comment on the proposal.**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | It is OK to keep it. RAN1 currently discussing in email thread [100b-e-NR-L1enh-URLLC-PDCCH enhancements-01] if a single or more than one combination can be reported by the UE.  |
| Qualcomm | We propose to separate 11-2 so that the UE can report the mix of each of the Rel. 15 capabilities and the Rel. 16 capability with full flexibility. As an example, the UE may report the support of FG 3-5b under Rel. 15 signalling for a given band, but when 3-5b and the Rel. 16 capabilities are mixed on the same band, the UE should be able to more flexibly indicate which combination of the number of CCs for 3-5b and for Rel. 16 PDCCH are supportable. Otherwise, the UE may need to report conservatively, which is not desirable (not for UE vendors and not for the operators.) |
| Huawei/HiSilicon | Ok to delay the discussion till we have some agreement on how to report the number of CCs under email discussion [100b-e-NR-L1enh-URLLC-PDCCH enhancements-01]. However, we still think that instead of adding new FGs for this, adding a note in FG 11-2b “Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b” seems enough. In our understanding, one or more combination discussed under the email discussion right now is related to one combination of (R15 FG, R16 FG). As to the flexibility on the number of CCs for different Rel-15 FGs, since we don’t have this kind of flexibility in Rel-15 also. We are open to discuss more though.  |
| Samsung | Based on the discussion on the WI email thread, it looks like there may be mismatch in understanding of meaning of this signaling. In our view, component 5 of 11-2 and 11-2b are about blind detection capability, and the contents in the note of the feature list are written in that way. However, component description, e.g. ‘Capability on the number of CCs with Rel-16 PDCCH monitoring capability on all the serving cells.’ for 11-2, does not clearly sound like it. Also, what QC is proposing looks to be ‘the actual’ number of CC’s a UE performs monitoring with certain behavior which does not correspond to this. This is a valid thing to consider, but this would need to be a separate signaling from blind detection capability. It would be good if QC can confirm that what they propose is about ‘the actual’ number of CC’s, and not about blind detection capability. These two need to be separately discussed. For the note, rel-15 FG corresponds to blind detection capability is ‘PDCCH blind detection capability for CA’ which clearly reveals the nature, and something similar may need to be done here. |
| DOCOMO | Support to keep it. Although it is discussed in the email discussion [100b-e-NR-L1enh-URLLC-PDCCH enhancements-01] whether UE can report single or more than one combination of Rel-15 and Rel-16 PDCCH monitoring carriers, we think it does not affect to the number FGs. UE could report multiple combinations by multiple components of single FG. |
| Apple | As mentioned in our UE feature contribution and on Monday, we would like to modify 11-2 to support signalling separate capabilities depending on the Rel-15 capability reported. By splitting 11-2b into 3 features, it allows the UE to report different capabilities corresponding to different Rel-15 features. For example, the UE may potentially report larger number of CCs for the combination of 3-1 and 11-2 than for the combination of 3-5b and 11-2. Otherwise, the UE would have to report conservatively, i.e., report the number corresponding to the most complicated one among 3-1, 3-2 and 3-5b (if all are supported), which is most likely to be 3-5b. |
| Ericsson | Support to keep the FG.  |
| Intel | Support to keep the FG 11-2b.  |
| MediaTek | Support to keep this FG.  |

## 5.2 Discussion 6

**Companies are encouraged to provide views on whether or not to introduce separate capabilities for mixed Rel-16 capability with Rel-15 PDCCH monitoring capability FG 3-1, FG 3-2, FG 3-5b on different serving cells.**

 **Introducing separate capabilities for FG3-1, 3-2, 3-5b supported by:**

 **Objected (i.e., keeping it as single FG) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Confirm the proposal from UE features session, i.e. do not split it further.  |
| Qualcomm | Yes, as responded under Discussion 5, splitting provides more flexibility in capability signalling and is beneficial.  |
| Huawei/HiSilicon | As given above for discussion 5.  |
| Samsung  | As mentioned in discussion 5, we think there seems to be mismatch on understanding regarding meaning of this. If this is about ‘the actual’ number of CC’s a UE performs monitoring, then we are open to discuss. This discussion should be separate from BD capability. We are OK to first discuss BD capability and how to indicate actual monitoring support later. |
| DOCOMO | We support not to introduce the separate capabilities. In Rel-15, the blind detection for CA is separately reported from Rel-15 PDCCH monitoring capabilities i.e. FG3-1, FG3-2, and FG3-5b, as FG6-5a. In the same manner, it is natural the current FG structure for Rel-16. |
| Apple | Support introducing separate FGs. |
| Ericsson | Do not support splitting the FG due to Rel-15 monitoring capability. |
| Intel | Further separation based on R15 PDCCH capabilities not necessary. |
| MediaTek | We don’t see the need to introduce separate capabilities for mixed Rel-16 capability with Rel-15 PDCCH monitoring capability FG 3-1, FG 3-2, FG 3-5b on different serving cells. |

In Monday UE features session, following proposal was discussed.

**Proposal**:

FG11-2b is not split for FG3-1, 3-2, 3-5b, but adding note in FG11-2b “Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b”

Supported by: Huawei, Nokia, DOCOMO, Intel, Ericsson, ZTE

 Objected by: Qualcomm, Apple

## 5.3 Discussion 7

**If separate capabilities for mixed Rel-16 capability with Rel-15 PDCCH monitoring capability FG 3-1, FG 3-2, FG 3-5b on different serving cells are not introduced, companies are encouraged to provide views on candidate values for capability on number of CCs with FG 3-1, FG3-2, and FG3-5b.**

|  |  |
| --- | --- |
| Company | Comment |
| Intel | Perhaps there is a typo in the question. It should perhaps say, “If separate … are ~~not~~ introduced, …” |
|  |  |
|  |  |
|  |  |

# **Conclusion**

**Agreements**:

* FG11-2 is kept.

**FL proposals:**

* Following FGs are included in UE features list for URLLC.
	+ 11-1 Monitoring DCI format 1\_2 and DCI format 0\_2
	+ 11-1a Monitoring both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 in the same search space
	+ 11-2 Rel-16 PDCCH monitoring capability (already agreed)
	+ 11-2b Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells
		- Adding a note that “Rel-15 monitoring capability here is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b”

TBD

# **References**

[1] R1-2001484 RAN1 UE features list for Rel-16 NR after RAN1#100-E Moderator (AT&T, NTT DOCOMO, INC.)

[2] R1-2001632 Discussion on UE feature for URLLC/IIoT ZTE

[3] R1-2001721 Discussion on Rel-16 URLLC/IIOT UE features vivo

[4] R1-2001782 Discussion on UE features for URLLC/IIoT OPPO

[5] R1-2001791 On UE Features for URLLC and IIoT Ericsson

[6] R1-2001795 UE features for URLLC China Unicom

[7] R1-2001828 Views on Rel-16 UE features for NR URLLC/IIoT MediaTek Inc.

[8] R1-2001927 Discussion on UE features for URLLC/IIoT LG Electronics

[9] R1-2002019 On UE features for Rel-16 eURLLC and IIoT Intel Corporation

[10] R1-2002070 Discussion of UE features for NR URLLC/IIoT CATT

[11] R1-2002154 UE features for URLLC/IIoT Samsung

[12] R1-2002352 Discussions on UE Features for URLLC/IIoT Apple

[13] R1-2002399 UE features for URLLC/IIoT Panasonic Corporation

[14] R1-2002482 On UE features for URLLC/IIOT Nokia, Nokia Shanghai Bell

[15] R1-2002566 Discussion on eURLLC and IIOT UE features Qualcomm Incorporated

[16] R1-2002591 Rel-16 UE features for URLLC Huawei, HiSilicon