**3GPP TSG RAN WG1 #100bis-e R1-2002873**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-06]

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-06] Email discussion/approval on issues with capability signaling impacts on FGs related to PDCCH enhancements for URLLC (27th-29th April) – Hiroki (DCM)

* Discuss whether or not FG11-1 needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”
	+ If differentiation is needed for both,
		- Whether/how to clarify capability interpretation for “support mixture of FDD/TDD and/or FR1/FR2”
* Discuss whether or not FG11-1a needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”
	+ If differentiation is needed for both,
		- Whether/how to clarify capability interpretation for “support mixture of FDD/TDD and/or FR1/FR2”
* Discuss followings on 11-2
	+ Whether or not reporting type is FSPC for FG11-2
		- For component 5), whether different reporting type should be defined for component 5)
	+ Whether or not to merge component 1) and 3), and component 2) and 4)
	+ Whether or not to add a new component to indicate if the UE can support non-aligned spans
* Discuss whether or not report type of 11-2b is per UE per FSPC
	+ If it is per UE,
		- Whether or not FG11-2b needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”
* Note that discussed FGs in this email discussion are derived by outcome of high priority email discussion in FL proposal 1

In the email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-01], following agreements were made.

**Agreements**:

FG11-2 is kept

**Agreements:**

* 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)

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

Based on agreements and [1], FG11-1 can be defined 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****( 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
 | TBD | Yes | N/A |  | Per UE | [No] | [No] | [N/A]  |  | Optional with capability signalling |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | * No perquisite FG needed.
* Both the FDD/TDD and FR1/FR2 differentiations should be YES. (This should be the case for any FG with a per-UE capability signaling type; otherwise, if the UE can support the feature in all the bands and band combos, but the network does not, the feature cannot be tested properly.)
* The differentiation is from the perspective of the scheduling cell.
 |
| Huawei/HiSilicon | * No perquisite FG needed.
* As to FDD/TDD and FR1/FR2 differentiations, we still don’t see the necessity to put YES. In TS 38.306, there are many FGs with per UE reporting with “No” for these two columns.
 |
| Intel | Pre-requisite = Not needed.Type = Per-UE.No need for FDD/TDD or FR1/FR2 differentiation. We have similar understanding as HW/HiSi that there exists many optional FGs from R15 that are per-UE with no xDD/FRx differentiation. |
| Apple | * Prerequisite FG not needed.
* FDD/TDD differentiation: No
* FR1/FR2 differentiation: No
 |
| Ericsson | * Remove ‘TBD’ under prerequisite FG column, i.e., no need of prerequisite.
* No for FDD/FDD differentiation;
* No for FR1/FR2 differentiation;
 |
|  |  |

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

**Based on the feedbacks, at least following points should be discussed for FG11-1.**

* **Whether or not FG11-1 needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”**
	+ **If differentiation is needed for both,**
		- **Whether/how to clarify capability interpretation for “support mixture of FDD/TDD and/or FR1/FR2”**

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| [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. |

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

Based on agreements and [1], FG11-1a can be defined 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****( 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 (TBD) | Yes | N/A |  | Per UE | [No] | [No] | [N/A] |  | Optional with capability signalling |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | * Both the FDD/TDD and FR1/FR2 differentiations should be YES. (This should be the case for any FG with a per-UE capability signaling type; otherwise, if the UE can support the feature in all the bands and band combos, but the network does not, the feature cannot be tested properly.)
* The differentiation is from the perspective of the scheduling cell.
 |
| Huawei/HiSilicon | As to FDD/TDD and FR1/FR2 differentiations, we still don’t see the necessity to put YES. In TS 38.306, there are many FGs with per UE reporting with “No” for these two columns.  |
| Intel | Pre-requisite = Not needed.Type = Per-UE.No need for FDD/TDD or FR1/FR2 differentiation. We have similar understanding as HW/HiSi that there exists many optional FGs from R15 that are per-UE with no xDD/FRx differentiation.  |
| Apple | * FDD/TDD differentiation: No
* FR1/FR2 differentiation: No
 |
| Ericsson | * Remove ‘(TBD)’ under prerequisite FG column, i.e., confirm 11-1 as prerequisite.
* No for FDD/FDD differentiation;
* No for FR1/FR2 differentiation;
 |

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

**Based on the feedbacks, at least following points should be discussed for FG11-1a.**

* **Whether or not FG11-1a needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”**
	+ **If differentiation is needed for both,**
		- **Whether/how to clarify capability interpretation for “support mixture of FDD/TDD and/or FR1/FR2”**

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| [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.
 |

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

Based on agreements and [1], FG11-2 can be defined 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****( 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 applied
3. 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 applied
5. Capability on the number of CCs with Rel-16 PDCCH monitoring capability on all the serving cells.
 | 3-5b (TBD) | Yes | N/A |  | [FSPC]FFS: Compoent 5) reported per UE | [N/A] | [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) | 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} |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| --- | --- |
| Company | Comment |
| Qualcomm | * No need to separately report C and M for each (X,Y,u) unless RAN1 agreed to different sets.
* Supported combinations of (X,Y,u) should be added as a component.
* Capability type could be FS or FSPC
* Differentiation is not needed.
* No need to perquisite FG. FG 3-5b should be removed.
* We also proposed to add a new (X,Y) pattern, i.e., (X,Y) = (3,2) to enable the PDCCH configuration with 4 spans per slot. This would be desirable since the UE can also report the support of 4 TBs per slot.
 |
| Huawei/HiSilicon | * Based on the potential number of C and M for different combinations, it is ok to merge component 1) and component 3), and accordingly merge component 2 and component 4) also.
* Based on the current potential number of C and M from this meeting, it is ok to add a component for “supported combination of (X, Y, u).
* At this stage, it seems impossible for us to introduce a new patter (3, 2) considering the potential discussion effort of C and M.
 |
| Intel | Agree that dependence on support of FG 3-5b should be removed. Type = FS is sufficient.FDD/TDD and FR1/FR2 differentiation not applicable.Merge components 1 and 3; and components 2 and 4. There is no case whereby the UE can report support of one component and not the other.We do not see that adding (X, Y) = (3,2) combination is necessary, especially considering the time it has taken to converge on the BD/CCE requirements for the combinations agreed so far (and still not concluded). If Cap #1 vs. Cap #2 separation is pursued, FG 11-2 should be split into separate rows. Even in the current form, the following is not accurate: 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;Also, the description should be changed to “A list of (X, Y) pairs for processing Capability 1/2", etc. |
| Apple | * Also agree that prerequisite 3-5b should be removed.
* It makes sense to merge component 1) and 3) in 11-2.
* We do not see a need to add the (X, Y) = (3,2) combination. Agree with Huawei that this would be a long, difficult discussion for setting C and M.
* Per FSPC. Component 5 can be reported per UE. In this case, it may need to be moved to a new FG.
* No FDD/TDD and FR1/FR2 differentiation.
* Whether or not to add a new component to indicate if the UE can support non-aligned spans will depend on the outcome of the maintenance session.
 |
| Ericsson | * For reporting type, it should be per UE or per FS. As a reference, FS is used for signaling type in FG 3-5b. Regarding FFS for component 5), the reporting type for component 5) should be per UE.
* Do not introduce separate UE capabilities C(X,Y,μ), M(X,Y,μ) for different processing capabilities. UE processing capability #1 and #2 is not for PDCCH monitoring.
* We support merging components 1) and 3), and merging components 2) and 4).
* No for FDD/FDD differentiation; No for FR1/FR2 differentiation;
 |

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

**Based on the feedbacks, at least following points should be discussed for FG11-2.**

* **Whether or not reporting type is FSPC for FG11-2**
	+ **For component 5), whether different reporting type should be defined for component 5)**
* **Whether or not to merge component 1) and 3), and component 2) and 4)**
* **Whether or not to add a new component to indicate if the UE can support non-aligned spans**
* **Whether or not to remove the dependency of FG 11-2 on FG 3-5b**

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| [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.

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| 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} |

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| [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

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| 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.
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| [14] | Nokia, NSB | Fine with merging components 1 & 3, and components 2 & 4 |
| [15] | Qualcomm | Following updates are proposed.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

 |

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

Based on [1], FG11-2b can be defined as below although it is still under the discussion in [100b-e-NR-UEFeatures-URLLC/IIoT-01].

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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****( 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

Capability on the number of CCs with Rel-16 PDCCH monitoring capability | 11-2 (TBD) | Yes | N/A |  | [Per UE] | [No] | TBD | [N/A] | 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 |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm  | * For the simultaneous support of FG 3-5b and Rel. 16, the UE should be able to report the supported patterns. In particular, the support of (X,Y) patterns for PDCCH based on 3-5b cannot be the same as what the UE has reported under Rel. 15 3-5b. Otherwise, the UE may need to under-report its capability.
* The reporting type should be per FS including the possible patterns for Rel. 15 3-5b PDCCH and the Rel. 16 PDCCH. A per-UE capability for the mix case means that the UE has to support the same bands and band combinations as reported for Rel. 15 3-5b PDCCH and Rel. 16 PDCCH separately for the mix case as well and with the same bandwidth class. Again, this approach leads to significant underreporting by the UE.
* A single value for the number of carriers (min number of carriers for BD/CCE scaling) is sufficient. The reporting could be per UE the same as in Rel. 15. Once the value is reported, any combination of *(pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)* with the sum of the entries equal to the reported value is supported by the UE.
* Description under the Note column should be put in bracket for now until RAN1 decides the final values.
 |
| Huawei/HiSilicon | Probably better to delay the discussion of the details of the two components a little bit, depending on how much progress we can get from the email discussion.  |
| Intel | Under discussion as part of R16 eURLLC maintenance. Prefer to conclude there first to avoid having parallel discussions here. |
| Apple | * Type should be same as the Type for component 5 in FG 11-2.
* We understand from opponents in this discussion that there is a reluctance to create too many FGs especially if we consider that we may have to report FG 3-1, FG 3-2, and FGs 3-5b. To achieve the same result without increasing the FGs, we could report multiple sets of numbers within the same FG, with a FG number set to zero if the FG is not supported e.g. {Rel-16, 3-1} {Rel-16, 3-2}{Rel 16, 3-5x} where 3-5x covers all the 3-5 type FGs.
 |
| Ericsson | * Regarding the open issues in brackets, we propose that all brackets are removed. That is,
* The FG supports Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells, where Rel-15 monitoring capability is subjected to the capability of FG 3-1, FG 3-2 and FG 3-5b.
* The signaling type for this FG should be per UE
* No need of FDD/TDD differentiation
* Since RAN1 has not concluded on the support of Rel-16 PDCCH monitoring for 60 and 120 kHz SCS, the need for FR1/FR2 differentiation remains TBD.
 |

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

**Based on the feedbacks, at least following points should be discussed for FG11-2b.**

* **Whether or not report type is per UE per FSPC**
	+ **If it is per UE,**
		- **Whether or not FG11-2b needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [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.

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| ***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 in the same CC | 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 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)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.  |

# **Conclusion**

TBD

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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****( 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
 | TBD | Yes | N/A |  | Per UE | [No] | [No] | [N/A]  |  | Optional with capability signalling |
| 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 (TBD) | Yes | N/A |  | Per UE | [No] | [No] | [N/A] |  | Optional with capability signalling |
| 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 applied
3. 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 applied
5. Capability on the number of CCs with Rel-16 PDCCH monitoring capability on all the serving cells.
 | 3-5b (TBD) | Yes | N/A |  | [FSPC]FFS: Compoent 5) reported per UE | [N/A] | [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) | 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} |

# **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

[16] R1-2002868 Summary on Email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-01] Moderator (NTT DOCOMO, INC.)