**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-04]

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-04] Email discussion/approval on the feature groups structure related to other enhancements for URLLC (20th-24th April) – Hiroki (DCM)

* Confirm to keep 11-5/6/7/8
* Discuss whether to introduce a separate capability signaling for the support of InvalidSymbolPattern for 11-5
* Discuss followings on 11-7
  + Whether or not to introduce separate UE capability for cross-carrier UL CI indication
  + Whether or not to introduce separate UE capability for the support of more than one monitoring occasion for DCI 2\_4 per slot
  + Whether to introduce a FG (e.g. 11-7b) that a UE is not expected to be scheduled with a CBG-based HARQ retransmission that does not include the full TB if the initial HARQ transmission was cancelled in case of inter-UE cancelation
* Discuss whether or not to keep FG11-7a
  + If removed, if UE reports to support FG11-7 and 6-23, it should automatically support the feature of FG 11-7a.
* Discuss whether or not to introduce following as new FG. If there is no consensus to add a new feature group at the end of this email discussion, the new feature group is not introduced in Rel-16.
  + “UL intra-UE multiplexing/prioritization of overlapping channel/signals with two priority levels in physical layer”
  + “Fixed TB CRC for interrupted initial PUSCH”

# **11-5: PUSCH repetition type B**

In [1], FG11-5 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 | 11-5 | PUSCH repetition type B | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots.  2) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [3) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  4) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  5) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  [6) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.]  [7) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured]  [8) Supported maximum number of actual repetitions within a slot]  [9) Supported PUSCH hopping scheme] |  | Yes | N/A |  | [Per UE]  FFS: Per band | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2] | Candidate value for component 8):  {2, 3, 4, 7, [8], [12]}  FFS: Whether to add new feature groups for the total number of unicast PUSCHs for different TBs per slot per CC, or just add some note here with an example below:  [The total number of unicast PUSCHs for different TBs per slot per CC is subjected to the capability reported by FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f]  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  [PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20].  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling |

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | ZTE | * Fine with rapporteur suggestion in ‘Note’ column that no need separate capability here but can be subjected to corresponding capabilities in Rel-15. * The capability signaling type should be per UE similar to PUSCH repetition over multiple slots in Rel-15. * Open to whether explicitly list components 3), 4) and 7) here, and open on adding components 8) and 9).  |  |  |  |  |  | | --- | --- | --- | --- | --- | | ***Suggested revision #4 on FG 11-5*** | | | | | | 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) | Note | | 11-5 | PUSCH repetition type B | 1. For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots.   2) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [3) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  4) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  5) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  [6) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.]  [7) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter InvalidSymbolPattern configured]  [8) Supported maximum number of actual repetitions within a slot]  [9) Supported PUSCH hopping scheme] | ~~[~~Per UE~~]~~  ~~FFS: Per band~~ | Candidate value for component 8):  {2, 3, 4, 7, [8], [12]}  ~~FFS: Whether to add new feature groups for the total number of unicast PUSCHs for different TBs per slot per CC, or just add some note here with an example below:~~  ~~[~~The total number of unicast PUSCHs for different TBs per slot per CC is subjected to the capability reported by FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f~~]~~  ~~FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?~~  ~~[~~PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20~~]~~.  ~~FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?~~  ~~[~~The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.~~]~~  ~~FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability?~~ | |
| [3] | vivo | * Regarding the 1st FFS, no need to add new feature groups. Having a note should be sufficient, * Regarding the 2nd FFS, no strong opinion. * Regarding the 3rd FFS, no strong opinion whether to separate SFI or just have a note as proposed. However, there should be a separate capability signalling regarding InvalidSymbolPattern as it is a new feature which cannot be covered by Rel-15 FG 3-6. * Regarding the 4th FFS, no need to separate DCI format 0\_1 and 0\_2. * Support adding component 9) Supported PUSCH hopping scheme |
| [4] | OPPO | * No need to support the following FFS:   + FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?   + FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and *InvalidSymbolPattern* is configured. Can we just add some note here with an example below for compromise?   + FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? |
| [6] | China Unicom | * Support setting separate UE capabilities according to the total number of unicast PUSCHs for different TBs per slot per CC and UE processing time capability. * It is not necessary to set separate UE capabilities according to the DCI format 0-1or 0-2 * It is not necessary to set separate UE capabilities according to dynamic grant and configured grant * It is better to support separating UE capabilities for frequency hopping. * Support separating UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured for DG PUSCH. * It is preferred to add “actual” to limit the actual repetitions within a slot for component 8 * Remove sub-bullets under component 1 for simple and clear. |
| [7] | Media Tek Inc. | FG11-5, the following suggestions are made;   * Support the addition of the following note as proposed by the rapporteur: *“The total number of unicast PUSCHs for different TBs per slot per CC is subjected to the capability reported by FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f”*. The numbers defined in the Rel-15 features are more enough to offer good implementation flexibility, and there is no need to define new redundant features. * There is no need to add the following note as proposed by the rapporteur: “*PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.*” * Remove component 9) “*[9) Supported PUSCH hopping scheme]*”.   + There is no need to add component to report the hopping pattern. There is already a UE feature in Rel-15 for reporting the support of inter-slot hopping. So, inter-slot hopping shouldn’t be reported (again) part of this feature. Also, there is no need to add a component to report the inter-repetition hopping, a UE that supports FG11-5 should support inter-repetition hopping. |
| [8] | LGE | * On FG 11-5, it should be clear whether component 8 is for single TB or for different TBs. As Rapporteur’s view, we would have UE capability on the total number of unicast PUSCHs for different TBs per slot per CC. If component 8 restricts the total number of actual repetiton for different TB per slot, the total number of unicast PUSCH would be restricted by the smaller of those two capability. If component 8 restricts the total number of actual repetiton for a TB per slot, number of actual repetition may not be restricted by the number of unicast PUSCH in a slot. We don’t have strong view on that, we think that following questions need to be clarified: * Are two actual repetitions in a slot counted as two unicast PUSCH in a slot? * Is component 8 for different TB or only for single TB? * Regarding FFS on the separation between DG and CG, we think it is not necessary to have separated FG for dynamic grant and configured grant. We support Rapporteure suggestion, to have a simple note “PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20”. * Regarding the FFS on the seperation between DCI format 0\_1 and 0\_2, we are fine with majority view, i.e., no separation. |
| [7] | Intel | * For Component #9, the suggested text is not appropriate as a description of a component feature. We propose to update to “*9) Frequency hopping based on reported capability*”. * Also, if we take this approach, then need to add the candidate values that may be indicated in the Note column – *“Candidates for Component 9): {No hopping; Inter-slot hopping; Inter-repetition hopping}”*. |
| [10] | CATT | We do not think component 8) supported maximum number of actual repetitions within a slot is needed. In addition, the square brackets of component 3/6/9 can be removed. |
| [11] | Samsung | * There is no need to explicitly list 3) and 6) * It is preferable to have [8) Supported maximum number of actual repetitions within a slot]. |
| [12] | Apple | There are many open points regarding whether to split this FG further based on different aspects. We think it makes sense to separate the support of *InvalidSymbolPattern*, because this is not considered as an essential part of PUSCH repetition Type B (i.e. can still work without it). For the other aspects, we do not see the need to split the FG further, either because the existing FGs can be reused, or because we do not see much additional complexity. |
| [13] | Panasonic | * For the questions from the rapporteur,   + *For question a) and b), add a note “ the total number of unicast PUSCHs for different TBs per slot per CC is subjected to the capability reported by FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f”*   + *For question c),add a note “ PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20”*   + *For question* d), add a note “*The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6”*   + *For q*uestion e), *add “9) Supported PUSCH hopping scheme”* to let UE to report the supported hopping scheme   + *For q*uestion f), not introduce separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B |
| [14] | Nokia, NSB | * Rapporteur Question a): We still see no need for capabilities on PUSCH per TB per slot, as the Rel-15 capabilities are already in place and can be applied directly (with the understanding of one TB per Rel-15 PUSCH). * Rapporteur Question b): See no need for it, we can use the Rel-15 indication of UE proc cap 1 & 2. * Rapporteur Question c): We do not see a difference between CG and DG here, therefore no need for separate capability. Of course the UE would need to indicate CG support in general (i.e. at least Rel-15 CG, i.e. 5-19 / 5-20). * Rapporteur Question d): No need for separate capability for SFI handling. Naturally the support of dynamic SFI would be subject to the support of SFI handling (i.e. Rel-15 capability 3-6). * Rapporteur Question e): we don’t see a need for separate capability here. Specifically as for PUSCH repetition Type B there is any now support for intra-repetition hopping, but the two defined hopping schemes follow the Rel-15 inter-slot hopping in a way, that each repetition is having a different hop. So basically a UE supporting inter-slot FH support (i.e. 5-10), should also be able to support the FH schemes for PUSCH repetition Type B. * Rapporteur Question f): we are fine with rapporteur proposal. |
| [15] | Qualcomm | Following updates are proposed.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 11-5a | PUSCH repetition type B with 1 unicast PUSCHs per slot per CC with UE processing time capability 1 | 1. For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 1 unicast PUSCHs per slot per CC with UE processing time capability 1. 2. Supported scheduling mode   3 Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot  [10) Supported PUSCH hopping scheme] |  | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5b | PUSCH repetition type B with up to 2 unicast PUSCHs per slot per CC with UE processing time capability 1 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 2 unicast PUSCHs per slot per CC with UE processing time capability 1.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot   1. [10) Supported PUSCH hopping scheme] | 5-12 | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5c | PUSCH repetition type B with up to 7 unicast PUSCHs per slot per CC with UE processing time capability 1 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 7 unicast PUSCHs per slot per CC with UE processing time capability 1.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot   1. [10) Supported PUSCH hopping scheme] | 5-12a | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5d | PUSCH repetition type B with up to 4 unicast PUSCHs per slot per CC with UE processing time capability 1 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 4 unicast PUSCHs per slot per CC with UE processing time capability 1.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot   1. [10) Supported PUSCH hopping scheme] | 5-12b | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5e | PUSCH repetition type B with up to 3 unicast PUSCHs per slot per CC with UE processing time capability 1 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 3 unicast PUSCHs per slot per CC with UE processing time capability 1.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot  [10) Supported PUSCH hopping scheme] | 5-12c | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5f | PUSCH repetition type B with 1 unicast PUSCHs per slot per CC with UE processing time capability 2 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with 1 unicast PUSCHs per slot per CC with UE processing time capability 2.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot  [10) Supported PUSCH hopping scheme] | 5-5c | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5g | PUSCH repetition type B with up to 2 unicast PUSCHs per slot per CC with UE processing time capability 2 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 2 unicast PUSCHs per slot per CC with UE processing time capability 2.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot  [10) Supported PUSCH hopping scheme] | 5-13d | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5h | PUSCH repetition type B with up to 7 unicast PUSCHs per slot per CC with UE processing time capability 2 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 7 unicast PUSCHs per slot per CC with UE processing time capability 2.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot  [10) Supported PUSCH hopping scheme] | 5-13e | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5i | PUSCH repetition type B with up to 4 unicast PUSCHs per slot per CC with UE processing time capability 2 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 4 unicast PUSCHs per slot per with UE processing time capability 2.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot  [10) Supported PUSCH hopping scheme] | 5-13f | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signalling | | 11-5j | PUSCH repetition type B with up to 3 unicast PUSCHs per slot per CC with UE processing time capability 2 | 1) For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots with up to 3 unicast PUSCHs per slot per with UE processing time capability 2.    2)Supported scheduling mode  3) Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH.  [4) The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field.]  5) PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG).  6) S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14.  7) TBS is determined based on L indicated in TDRA table entry reusing Rel-15 mechanism.  8) Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter *InvalidSymbolPattern* configured  9) Supported maximum number of actual repetitions within a slot  [10) Supported PUSCH hopping scheme] |  | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value for component 9):  {1, 2, 3, 4, 7, 8, 12, 16}  Candidate value for component 2: {self-carrier scheduling, cross-carrier scheduling, none)  FFS: Whether to set separate UE capabilities for dynamic grant and configured grant. Can we just add some note here with an example below for compromise?  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20.  FFS: Whether to set separate UE capabilities for the case that dynamic SFI is configured and InvalidSymbolPattern is configured. Can we just add some note here with an example below for compromise?  [The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6.]  FFS: Whether to set separate UE capabilities for DCI format 0\_1 and DCI format 0\_2 for PUSCH repetition type B. Can we go majority view that no separate UE capability? | Optional with capability signaling | |
| [16] | Huawei, HiSilicon | * Components 6) for FG11-4 should be kept. This is similar to 5-12, 5-12a, 5-12b, 5-13d, 5-13e, 5-13f in Rel-15, which restricts the number of PUSCHs within a slot. * As to whether to add new feature groups for the total number of unicast PUSCHs for different TBs per slot per CC, it seems the note “*The total number of unicast PUSCHs for different TBs per slot per CC is subjected to the capability reported by FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f*” proposed by rapporteur is sufficient. * As to whether to set separate UE capabilities for dynamic grant and configured grant, it seems the note “*PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20*” is enough. * As to whether to set separate UE capabilities for the case that dynamic SFI is configured and *InvalidSymbolPattern* is configured, it seems the note “ The case that both dynamic SFI and *InvalidSymbolPattern* are configured is applied only if UE reports the support of FG3-6” is sufficient. * As to the PUSCH hopping scheme, it is ok to let UE to report the supported hopping scheme, the candidate value for component 9) can be {No hopping; Inter-slot hopping; Inter-repetition hopping}. |

## 2.1 Discussion 1

**The proposal is to confirm that FG11-5 is kept.**

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

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | OK to keep it. |
| Ericsson | We agree to keep FG11-5. We see no need to split the feature group depending on number of unicast PUSCH for different TBs per slot per CC. It is sufficient with a note and to reuse the capability reported by FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f. |
| Huawei/HiSilicon | Agree with the proposal.  As to the question “Whether to set separate UE capabilities for the total number of unicast PUSCHs for different TBs per slot per CC” and “Whether to set separate UE capabilities for different UE processing time capability” which may have impact on the structure of the FG, based on the views from companies, it seems common understanding is that there should be UE capability on the total number of unicast PUSCHs for different TBs per slot per CC. The key question is whether we need to add new FGs corresponding this, or we can just reuse the Rel-15 capabilities. According to the description of FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f defined in Rel-15, it can be applicable here also. Therefore, for simplicity, instead of adding a bunch of new feature groups, adding the following note is sufficient in our understanding:  *The total number of unicast PUSCHs for different TBs per slot per CC is subjected to the capability reported by FG 5-12, 5-12a, 5-12b, 5-13d, 5-13e and 5-13f* |
| DOCOMO | We support the proposal. |
| Qualcomm | The support of this feature, i.e., b2b PUSCH repetition is new to Rel. 16. Hence, the capabilities from Rel. 15 cannot be used. As an example, if the UE reports its support of 2 unicast PUSCHs per slot with capability 2 under Rel. 15 set of FGs, it does not necessary mean that the same number of unicast TBs per slot with the same timing capability can be supported with Type B PUSCH repetition. Again, the complexity of the two schemes is not the same.  Further, under Rel. 15 DL slot aggregation, each PUSCH within the repetition bundle was counted as one unicast TB and as part of the maximum number of TBs supported by the UE per slot. For PUSCH Type B too, the same principle should be applied, i.e., each PUSCH within a bundle is thought of as one unicast TB and counted as part of the maximum number of TBs per slot. |

## 2.2 Discussion 2

**Companies are encouraged to provide views on whether or not to introduce a separate capability signaling for the support of InvalidSymbolPattern for 11-5.**

**Introducing a separate capability supported by:**

**Objected (i.e., not introducing it) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | No separate capability. The InvalidSymbolPattern is integral part of the PUSCH repetition Type B design. |
| Ericsson | We see no need to introduce a separate capability. The UE needs to support invalid symbols from e.g. semi-static DL symbols, and most likely also from other symbols such as symbols used for SSB. Therefore the invalidsymbolpattern should also be supported as a basic part of the feature. |
| Huawei/HiSilicon | Support of invalid symbol pattern will increase additional UE complexity, thus it is slightly preferred to set a separate UE capability. However, we are fine with no additional capability either. |
| DOCOMO | We would prefer not to introduce the separate capability signaling for the support of InvalidSymbolPattern. As noted, if UE reports FG3-6 and FG11-5, it supports InvalidSymbolPattern as well. |
|  |  |

# **11-6: PUSCH repetition Type A**

In [1], FG11-6 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 | 11-6 | PUSCH repetition Type A | 1) PUSCH transmission with Rel-15 behavior with or without slot aggregation.  • With slot aggregation, the number of repetitions can be [either semi-statically configured (as in Rel-15) or] dynamically indicated (as agreed for Rel-16).  • When dynamically indicated, the number of repetitions is jointly coded with SLIV in TDRA table, by adding an additional column for the number of repetitions in the TDRA table. | 2-12, 2-13, 2-14, 2-15 | Yes | N/A |  | [Per UE] | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2] | FFS: Whether to add a component for the supported maximum number of PUSCH repetitions | Optional with capability signalling |

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

|  |  |  |  |
| --- | --- | --- | --- |
| [3] | vivo | We suggest to make following revision to component 1), as the semi-static part is Rel-15 feature thus no need to duplicate here.   |  | | --- | | 1) PUSCH transmission with Rel-15 behavior with or without slot aggregation.  • With slot aggregation, the number of repetitions can be ~~[either semi-statically configured (as in Rel-15) or]~~ dynamically indicated (as agreed for Rel-16). |   Regarding FFS Whether to add a component for the supported maximum number of PUSCH repetitions, we think there is no need to add. |
| [10] | CATT | We think it sufficient to include dynamic indication of repetition factor which is different from Rel-15 FG 5-17 PUSCH repetitions over multiple slots and we think FG 5-17 should be one of the prerequisite feature groups of FG 11-6.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 11-6 | PUSCH repetition Type A | 1) PUSCH transmission with Rel-15 behavior with or without slot aggregation.  • With slot aggregation, the number of repetitions can be ~~[either semi-statically configured (as in Rel-15) or]~~ dynamically indicated (as agreed for Rel-16).  • When dynamically indicated, the number of repetitions is jointly coded with SLIV in TDRA table, by adding an additional column for the number of repetitions in the TDRA table. | 2-12, 2-13, 2-14, 2-15, 5-17 | Yes | N/A |  | [Per UE] | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2] | ~~FFS: Whether to add a component for the supported maximum number of PUSCH repetitions~~ | Optional with capability signalling | |
| [14] | Nokia, NSB | We do not see a need for separate capability on the number of supported repetitions. A similar approach has been followed in Rel-15 already. |
| [15] | Qualcomm | Following updates are proposed.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 11-6 | PUSCH repetition Type A | 1) PUSCH transmission with Rel-15 behavior with or without slot aggregation.  • With slot aggregation, the number of repetitions can be [either semi-statically configured (as in Rel-15) or] dynamically indicated (as agreed for Rel-16).  • When dynamically indicated, the number of repetitions is jointly coded with SLIV in TDRA table, by adding an additional column for the number of repetitions in the TDRA table.   1. Maximum number of PUSCH repetitions |  | Yes | N/A |  | PerBand | N/A | N/A |  | Componenet-1  candidate value set: {‘semi-static only’, ‘both semi-static and dynamic’}  Componenet-2  candidate value set: {1,2,3,4,7,8,12,16} | Optional with capability signalling | |

## 3.1 Discussion 3

**The proposal is to confirm that FG11-6 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.  The Rel-15 (i.e. semi-static) parts should be removed (as this is Rel-15 capability), only the dynamic indication is required in the description. |
| Ericsson | We support the feature with the removal of the text in brackets in component 1. We see no need to add a component for the supported maximum number of PUSCH repetitions. |
| Huawei/HiSilicon | Support the proposal. Ok to remove the semi-static part also, i.e. remove the text in the bracket in the first sub-bullet. |
| DOCOMO | We support the proposal. |
| Qualcomm | We are fine to keep the row. The number of PUSCH repetitions can be added as a component here. |

# **11-7: UL cancelation scheme**

In [1], FG11-7 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 | 11-7 | UL cancelation scheme | 1) Supports group common DCI (i.e. DCI format 2\_4) for cancelation indication  2) UL cancelation for PUSCH  • Cancellation is applied to each PUSCH repetition individually in case of PUSCH repetitions  3) UL cancelation for SRS symbols that overlap with the cancelled symbols  [4) For the serving cell, the UE determines the first symbol of the symbols to be the first symbol that is after from the end of a PDCCH reception where the UE detects the DCI format 2\_4, where is provided by higher layer.] |  | Yes | N/A |  | [Per UE]  FFS: FS | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2] | FFS: Whether to split this FG 11-7 into one feature group for the case of UL CI on the same CC and another feature group for the case of UL CI on another CC  FFS: Whether to add new FG with FG11-7 as prerequisite for the support of more than one monitoring occasion for DCI 2\_4 per slot? Can we just add the following note to address the concern?  [More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b] | Optional with capability signalling |

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | Regarding the 1st FFS in note, we think it make sense to have separate feature groups for same CC and cross-CC UL CI operation.  Regarding the 2nd FFS in note, we think have a note as proposed should be fine. |
| [4] | OPPO | For 11-7, it is suggested to add cancellation timeline in component due to it impacts UE implementation. |
| [7] | Media Tek Inc. | For FG11-7, we have the following suggestions:   * Support the addition of the following note as proposed by the rapporteur: *“More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b”*. * Set separate UE capabilities for UL CI on the same CC and on another CC. Same-CC cancellation and cross-CC cancellation have different implementation complexity, and should be reported separately. |
| [8] | LGE | On FG 11-7, Tproc, 2 is in absolute time unit, however, d would be a value in symbol level. For simplicity, we would like to add unit. For example, “after Tproc, 2 +d symbol” or “after d symbol after Tproc, 2”.  Regarding FFS on more than one monitoring occasion, we support raportuer’s suggestion. If UE can monitor UL grant with <1 slot periodicity, UE should be able to monitor UL CI with <1 slot periodicity as well. It is not necessary to make specific monitoring capabilty only for UL CI. Moreover, UL CI already has restrcition in terms of the number of BD. If UL CI has same restriction on type 3 CSS like other DCI format, there won’t be a problem. |
| [10] | CATT | Component 4) has been captured in the physical specification and our understanding is that it should be followed once UL cancellation is supported. It doesn’t need to be included in the UE capability.  UL cancellation indication is used to cancel the uplink transmission within the target resource region, there is nothing about whether the UL CI is transmitted on the same CC or different CC. It is similar to pre-empted indication which can be transmitted on the same CC or different CC with PDSCH. The same logic should be applied here.  Whether more than one monitoring occasions for DCI format 2\_4 per slot is applied depends on the FG 3-5 or FG3-5a or FG-3-5b. We don’t see the necessity to add new FG with FG11-7 as prerequisite for the support of more than one monitoring occasion for DCI format 2-4 per slot. |
| [12] | Apple | We do not see the need to have a separate feature defined for the case with more than one monitoring occasions within a slot for DCI format 2\_4. The configuration should be allowed as long as it is supported by the UE PDCCH monitoring capability (e.g. the UE supports FG 3-5/3-5a/3-5b/11-2).  **Proposal 13: Do not define a separate feature for the case with more than one monitoring occasions within a slot for DCI format 2\_4.**  On the same-CC and cross-CC monitoring of DCI format 2\_4, we would prefer to separate them. The same-CC and cross-CC handling may be very different in UE implementation, and the timeline consideration can also be different.  **Proposal 14: Split FG 11-7 into two FGs, one for same-CC monitoring and one for cross-CC monitoring of DCI format 2\_4.**  For FG 11-7a, we support adding this FG to capture what was concluded in RAN1#100-e email discussions.  **Proposal 15: Introduce FG 11-7a.**  On the handling of CBG-based transmission, there is the same issue on PUSCH cancelation as in intra-UE prioritization. Similarly, we propose:  **Proposal 16: Introduce a FG (e.g. 11-7b) that a UE is not expected to be scheduled with a CBG-based HARQ retransmission that does not include the full TB if the initial HARQ transmission was cancelled in case of inter-UE cancelation.** |
| [13] | Panasonic | Question 1: Whether to set separate UE capabilities for >1 monitoring occasion within 1 slot when 1-slot is the configured UL CI monitoring periodicity?  Rapporteur agree with some companies that it can depend on Rel-15 UE capability, if UE report the support of FG 3-5/FG 3-5a/FG 3-5b, then it means that it can support more than one monitoring occasion within 1 slot. However, rapporteur guesses the concern from companies who said yes is that if we don't say anything here, it may mean if a UE wants to support FG 11-7 simultaneously it needs to support FG 3-5/FG3-5a/FG 3-5b, even it only intends to support one monitoring occasion per slot. Therefore, instead of adding a new FG, Can we just add the following to the Note column?  *More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b.*  We are ok with rapporteur's suggestion.  Question 2: Whether to set separate UE capabilities for UL CI on the same CC and on another CC?  It seems no explicit reason provided here why we need separate UE capability for the case of same CC and the case of UL CI on another CC. We may need more discussion, If you prefer separate UE capability, can you provide your detailed reason here?  Cross carrier UL CI requires cross-carrier related implementation where can impact the parallel processing per CC. Therefore, we see separate capability would be more reasonable. |
| [14] | Nokia, NSB | * + Rapporteur proposal on the monitoring: We are fine to have a note there. Anyhow, it should be clear that if UE does not support more than one PDCCH occasion per slot, then this would equally apply for UL CI monitoring.   + Rapporteur Question 2: We don’t see a need for separate capability for cross-carrier UL CI indication.   + Addition of component 4 could be fine. |
| [15] | Qualcomm | Following updates are proposed.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 11-7a | UL cancelation scheme on same CC | 1) Supports group common DCI (i.e. DCI format 2\_4) for cancelation indication on the same CC as PUSCH or SRS  2) UL cancelation for PUSCH  • Cancellation is applied to each PUSCH repetition individually in case of PUSCH repetitions  3) UL cancelation for SRS symbols that overlap with the cancelled symbols  [4) For the serving cell, the UE determines the first symbol of the symbols to be the first symbol that is after from the end of a PDCCH reception where the UE detects the DCI format 2\_4, where is provided by higher layer.] |  | Yes | N/A |  | FS | N/A | N/A |  | [More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b] | Optional with capability signalling | | 11-7b | More than one monitoring occasion for DCI 2\_4 per slot on same CC | Monitoring occasions per slot for DCI 2\_4 reception on the same CC as PUSCH or SRS  Supported combinations of (X, Y), where X is the minimum gap between monitoring occasions measured from beginning to beginning of the monitoring occasions, including across slots, and Y is the duration of the monitoring occasion, with both X and Y in units of symbols | 11-7a | Yes | N/A |  | FS | N/A | N/A |  | Candidate value set:  (X, Y) =  {(7, 3),  (7, 3) and (4, 3),  (7, 3) and (4, 3) and (3,2),  (7, 3) and (4,3) and (3,2) and (2,2),  (7,3) and (4,3) and (2,2)} | Optional with capability signaling | | 11-7c | UL cancellation scheme on another CC | 1) Supports group common DCI (i.e. DCI format 2\_4) for cancelation indication on a different CC as PUSCH or SRS  2) UL cancelation for PUSCH  • Cancellation is applied to each PUSCH repetition individually in case of PUSCH repetitions  3) UL cancelation for SRS symbols that overlap with the cancelled symbols  [4) For the serving cell, the UE determines the first symbol of the symbols to be the first symbol that is after from the end of a PDCCH reception where the UE detects the DCI format 2\_4, where is provided by higher layer.] |  | Yes | N/A |  | FS | N/A | N/A |  |  | Optional with capability signaling | | 11-7d | More than one monitoring occasion for DCI 2\_4 per slot on another CC | Monitoring occasions per slot for DCI 2\_4 reception on a different CC from PUSCH or SRS  Supported combinations of (X, Y), where X is the minimum gap between monitoring occasions measured from beginning to beginning of the monitoring occasions, including across slots, and Y is the duration of the monitoring occasion, with both X and Y in units of symbols | 11-7c | Yes | N/A |  | FS | N/A | N/A |  | Candidate value set:  (X, Y) =  {(7, 3),  (7, 3) and (4, 3),  (7, 3) and (4, 3) and (3,2),  (7, 3) and (4,3) and (3,2) and (2,2), (7,3) and (4,3) and (2,2)} | Optional with capability signaling | |
| [16] | Huawei, HiSilicon | * + No strong motivation to set separate UE capabilities for the UL CI on the same CC and on another CC.   + As to whether to add new FG with FG11-7 as prerequisite for the support of more than one monitoring occasion for DCI 2\_4 per slot, we don’t see strong motivation. The note “*More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b*” is enough. |

## 4.1 Discussion 4

**The proposal is to confirm that FG11-7 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. |
| Ericsson | We are ok to keep 11-7.  We think that component 4 is already captured in 38.213 and there is no need to have it here. In our view the parameter d must be supported to make the feature work. |
| Huawei/HiSilicon | Support the proposal. Depending on the outcome from discussion 5 below, we can see whether any update needed on the name of this FG. |
| DOCOMO | We support the proposal. |
| Qualcomm | Similar to self-carrier scheduling vs. cross-carrier scheduling, self-carrier cancellation and cross-carrier cancellation have different complexities. Hence, we propose to split this FG into two rows as proposed earlier and captured in the table above. |

## 4.2 Discussion 5

**Companies are encouraged to provide views on whether or not to introduce separate UE capability for cross-carrier UL CI indication.**

**Introducing a separate capability supported by:**

**Objected (i.e., not introducing it) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | We do not see a need for a separate capability here. |
| Ericsson | We prefer not introduce new capability for multiple CCs.  Introduction of separate FG for multiple CC cancellation will lead to more questions and issues, e.g. how single CC cancellation and multiple CC cancellation relates with multi-CC support and 11-7a. Specifically:   * can UE be configured with multiple CCs, but UL CI is configured only for one CC?   If yes, does it mean that all intra band CC will be cancelled due to cancellation of single CC when UE doesn’t support 11-7a? |
| Huawei/HiSilicon | We don't see the necessity. We don't have separate UE capability for DL PI for Rel-15, similar rule can be used here. Therefore, unless strong motivation is identified, we prefer not to further split it. |
| DOCOMO | We prefer not to introduce separate capabilities but could be flexible considering that cross-carrier UL CI would require different UE implementation. |
| Qualcomm | As mentioned in our response to Discussion 4, we think the two cases should be separated. |

## 4.3 Discussion 6

**Companies are encouraged to provide views on whether or not to introduce separate UE capability for the support of more than one monitoring occasion for DCI 2\_4 per slot.**

**Introducing a separate capability supported by:**

**Objected (i.e., not introducing it) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Do not introduce it. The PDCCH monitoring capabilities overall (i.e. more than one occasion per slot) for the UE are anyhow indicated separately (independently of the DCI format). |
| Ericsson | We think that there is no reason to introduce separate capability, because limitation comes naturally with FG 3-5/FG3-5a/FG 3-5b. We are ok to add it as a note |
| Huawei/HiSilicon | No need to introduce separate FGs if we add the following note:  *More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b.*  Whether to support of more than one monitoring occasion for DCI format 2\_4 per slot can depend on Rel-15 UE capability, if UE report the support of FG 3-5/FG 3-5a/FG 3-5b, then it means that it can support more than one monitoring occasion within 1 slot. The concern from companies who said yes is that if we don't say anything here, it may mean if a UE wants to support FG 11-7 simultaneously it needs to support FG 3-5/FG3-5a/FG 3-5b, even it only intends to support one monitoring occasion per slot. Therefore, instead of adding a new FG, we just add the above note to the note column. |
| DOCOMO | We object to introduce this separate capability. |
| Qualcomm | We propose to define a capability for the number of monitoring occasions for DCI 2\_4 per slot. |

## 4.4 Discussion 7

**Companies are encouraged to provide views on whether or not to introduce a FG (e.g. 11-7b in [12]) that a UE is not expected to be scheduled with a CBG-based HARQ retransmission that does not include the full TB if the initial HARQ transmission was cancelled in case of inter-UE cancelation.**

**Introducing a separate capability supported by:**

**Objected (i.e., not introducing it) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Do not introduce it. If something for CBG-based clarification is needed then this could be done in 38.214. |
| Ericsson | This proposal sounds like limitation for RAN1 spec, but not the capability. Moreover, negative capability should be avoided. If the initial HARQ transmission consists of several repetitions, some of which are cancelled and some are transmitted, then the gNB can decode some CBGs that shouldn’t be retransmitted.  We do not support introducing 11-7b. |
| Huawei/HiSilicon | We don't see the necessity at this stage. We share similar view as Nokia that is seems sufficient to put this in 38.214 if RAN1 agree it is an issue. Agree with E// that according to RAN2 LS incapability FG should be avoided. |
| DOCOMO | We do not prefer the separate capability. |
| Qualcomm | We propose to include this FG. The reason for this capability is explained in detail in Section 4 of R1-1912960. |

# **11-7a: Cancellation of the overlapping PUSCHs in an intra-band UL CA without indication in the DCI format 2-4**

In [1], FG11-7a 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 | [11-7a] | Cancellation of the overlapping PUSCHs in an intra-band UL CA without indication in the DCI format 2-4 | 1) For a UE indicating the capability of *pa-PhaseDiscontinuityImpacts*, and if the PUSCH on at least one serving cell is cancelled, the UE may cancel the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on a the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell for which the DCI format 2\_4 is applicable to. | 6-23, 11-7 | Yes | N/A |  | [PerBand] | [N/A] | [N/A] | TBD | FFS: Whether to add this FG and the content for each column if added | Optional with capability signaling |

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | There was following conclusion in RAN1#100e based on which 11-7a should be kept.  Conclusion:   * It is possible for a UE to indicate both  *pa-PhaseDiscontinuityImpacts*  (i.e. 6-23) and the support of UL CI for intra-band UL CA * For a UE indicates a capability to cancel overlapping PUSCHs on different intra-band serving cells (if any), and the capability of *pa-PhaseDiscontinuityImpacts*, and if the PUSCH on at least one serving cell is cancelled, the UE cancels the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on a the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell for which the DCI format 2\_4 is applicable to.   **Proposal 10: Keep FG 11-7a.** |
| [4] | OPPO | In CA scenario, if UE reports the capability of *pa-PhaseDiscontinuityImpacts*, and the PUSCH on at least one serving cell is cancelled, the UE cancels the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). it is suggested to add as sub-feature group of 11-7 |
| [5] | Ericsson | While we recognize that FG [11-7a] reflects a RAN1 conclusion on intra-band cancellation, the meaning of this FG should be clarified. As stated in the conclusion, for a UE with indication of UL CI and capability of *pa-PhaseDiscontinuityImpacts*, the UE performs the cancellation on all other intra-band serving cells if intra-band UL CA is configured. Thus it is not straightforward why the UE need to report FG [11-7a]. It should be clarified that for a UE indicating *pa-PhaseDiscontinuityImpacts*, when FG [11-7a] is not indicated, UL CI cannot be applied in the scenario of intra-band UL CA.   1. FG [11-7a] is introduced with clarification that for a UE indicating *pa-PhaseDiscontinuityImpacts* but not FG [11-7a], UL CI cannot be applied in the scenario of intra-band UL CA. |
| [14] | Nokia, NSB | 11-7a: we have not identified the need for separate capability here for *pa-PhaseDiscontinuityImpacts*. A UE indicating 11-7 and 6-23, should automatically support also 11-7a. If needed, this could be spelled out as a new component in 11-7 if needed, but clearly no independent reporting is seen as needed. |
| [15] | Qualcomm | Following updates are proposed.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 11-7e | Cancellation of the overlapping PUSCHs in an intra-band UL CA without indication in the DCI format 2-4 | 1) For a UE indicating the capability of *pa-PhaseDiscontinuityImpacts*, and if the PUSCH on at least one serving cell is cancelled, the UE may cancel the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on a the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell for which the DCI format 2\_4 is applicable to. | 6-23, 11-7 | Yes | N/A |  | PerBand | N/A | N/A |  |  | Optional with capability signaling | |
| [16] | Huawei, HiSilicon | FG 11-7a should be kept as separate UE capability. |

## 5.1 Discussion 8

**Companies are encouraged to provide views on whether the bracket for FG11-7a is removed or FG11-7a is removed.**

**Keeping the FG[11-7a] (removing bracket) supported by:**

**Objected (i.e., support removing FG[11-7a] and if UE reports to support FG11-7 and 6-23, it should automatically support the feature of FG 11-7a) by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Support removing FG [11-7a]. |
| Ericsson | Support 11.7a, but change the FG to:   |  |  |  |  | | --- | --- | --- | --- | | [11-7a] | Independent cancellation of the overlapping PUSCHs in an intra-band UL CA | 1) For a UE not indicating the capability of *pa-PhaseDiscontinuityImpacts*, and if the PUSCH on at least one serving cell is cancelled, the UE cancels the (repetition of the) PUSCHs transmission only on intra-band serving cell(s) to be cancelled according to DCI format 2\_4, while all other intra-band serving cell(s) are not affected.. | Note column:  For cases when:   * *pa-PhaseDiscontinuityImpacts – true and 11-7a – true* * *pa-PhaseDiscontinuityImpacts – true and 11-7a – false* * *pa-PhaseDiscontinuityImpacts – false and 11-7a – false*   if the PUSCH on at least one serving cell is cancelled, the UE may cancel the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on a the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell for which the DCI format 2\_4 is applicable to. | |
| Huawei/HiSilicon | We are ok to keep FG 11-7a, i.e. removing the bracket. As Ericsson mentioned, some further clarification may be needed, we are open to discuss it in the following phase. |
| DOCOMO | We are fine to keep FG11-7a. |
| Qualcomm | Keep 11-7a. |

# **New Feature group proposal**

In [4], a new FG11-12 is proposed as below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| [4] | OPPO | * For 11-12, the feature group of UL intra-UE multiplexing/prioritization based on PHY priority level is missed in URLLC. Because UL intra-UE multiplexing/prioritization based on PHY priority level is also applied to solve collision between PUCCH and PUSCH, PUCCH and PUCCH, which is out of scope of intra-UE multiplexing/prioritization leaded by RAN2. So, it is suggested to be included in URLLC. Notes that this feature group is independent from up to two HARQ-ACK codebooks, because there are other intra UE prioritization cases than two HARQ-ACK codebooks, e.g. high priority SR and low priority PUSCH.  |  |  |  | | --- | --- | --- | | 11-12 | UL intra-UE multiplexing/prioritization of overlapping channel/signals with two priority levels in physical layer | Support intra-UE multiplexing/prioritization of UL overlapping channels/signals with two priority levels in physical layer (PHY)   1. Configuration of PHY priority level for CG PUSCH and SR, and dynamic indication of priority level for dynamic PUSCH 2. Prioritization between UL channels/signals with different PHY priority levels 3. Additional number of symbols (d1) needed beyond the PUSCH preparation time for cancelling a low priority UL transmission. 4. Additional number of symbols (d2) needed beyond the PUSCH preparation time for scheduling a high priority UL transmission that cancels a low priority UL transmission | |

In [15], new FGs are proposed 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 |
| 12. NR\_IIOT | 12-x | Fixed TB CRC for interrupted initial PUSCH | TB CRC set to all zeros for a re-transmission of a TB in case the initial transmission was cancelled | 5-25 | Yes | N/A |  | PerBand | N/A | N/A |  | The cancellation could be due to support of ULCI and/or intra-UE prioritization | Optional with capability signaling |

## 6.1 Discussion 9

**Companies are encouraged to provide views on whether new FG for “UL intra-UE multiplexing/prioritization of overlapping channel/signals with two priority levels in physical layer” is added or not.**

**Adding the new FG supported by:**

**Objected by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Not added. No need for this additional FG identified. |
| Ericsson | We don’t see a reason to introduce 11-12. We don’t see a difference between 11-12 and 12-1. In our understanding, 12-1 is already PHY layer feature group. |
| Huawei/HiSilicon | Not needed. Intra-UE multiplexing is defined in FG 12-1 already. As discussed for FG 11-4, we can add some component to reflect the prioritization among uplink channels. |
| DOCOMO | Not needed, this is covered by FG12-1. |

## 6.2 Discussion 10

**Companies are encouraged to provide views on whether new FG for “Fixed TB CRC for interrupted initial PUSCH” is added or not.**

**Adding the new FG supported by:**

**Objected by:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Not added. No need for this additional FG identified. |
| Ericsson | Not added. We don’t see a reason to introduce 12-x. In our understanding, gNB may or may not try to decode of some CBGs in cancelled PUSCH. Consecutively, it is up to gNB which CBGs should be retransmitted. Impact on UE is not clear. |
| Huawei/HiSilicon | The purpose is not clear for us. At this stage, we don't see the need to introduce new FG for this. |
| DOCOMO | Not necessary. We do not see clear benefit. |
| Qualcomm | We propose to include this FG. The reason for this capability is explained in detail in Section 4 of R1-1912960. We would like to ask all the companies, especially UE vendors, to take a look this section. The benefit (need) from the UE implementation point of view is clear. |

# **Conclusion**

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