**3GPP TSG RAN WG1#107-e R1-21nnnnn**

**e-Meeting, November 11th – 19th, 2021**

**Agenda Item: 8.2.2**

**Source: Moderator (Lenovo)**

**Title: Draft discussion [107-e-NR-52-71GHz-02] on PDCCH monitoring enhancements**

**Document for: Discussion, Decision**

# Introduction

Among other items, the WID "Extending current NR operation to 71 GHz" includes the following RAN1 objective:

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| Support enhancement to PDCCH monitoring, including blind detection/CCE budget, and multi-slot span monitoring, potential limitation to UE PDCCH configuration and capability related to PDCCH monitoring. |

As stated by the chairman:

[107-e-NR-52-71GHz-02] Email discussion/approval on PDCCH monitoring enhancements with checkpoints for agreements on November 15 and 19 – Alex (Lenovo)

Depending on the progress, new questions or proposal may be added after the defined checkpoints.

# Discussion

FL NOTE: Excerpts from submitted documents are listed in Section 3.

## Topic A1: Blind Decoding Capability, Multi-slot monitoring

### Issue A1-1: Multi-slot PDCCH monitoring capability and SS configuration limitations

In RAN1#106bis-e, the following agreement has been achieved:

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| * Multi-slot PDCCH monitoring is based on slots within a slot group   + Each slot group consists of X consecutive slots     - Slot groups are consecutive and non-overlapping     - The start of the first slot group in a subframe is aligned with the subframe boundary     - The start of each slot group is aligned with a slot boundary     - Reporting the BD/CCE budget for X=4/8 slots (for 480/960 kHz resp.) is mandatory (if UE supports the corresponding SCS), and is optional for X=[2]/4 slots (for 480/960 kHz resp.) * There is a common BD budget for all search spaces * FFS: Search space configuration   + For Group (1) SS     - A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots     - The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots     - The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)     - BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots   + For Group (2) SS     - A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots     - The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)   + The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group   + Support the following values of YGroup1 and YGroup2     - For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1,[1 or 2])     - For X=4: (YGroup1,YGroup2) = (2,2), (1,[1 or 2])     - For X=2: (YGroup1,YGroup2) = (1,[1 or 2])   + Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS   + Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS |

Additionally, other options w.r.t. potential limitations on the search space configurations had been discussed:

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| * + Option A     - A SS can be configured to be within Y consecutive slots within a slot group of X slots; the Y consecutive slots can be located anywhere within the slot group of X slots     - The location of the Y consecutive slots within the slot group of X slots is maintained across different slot groups     - BD attempts for all SS sets (Group (1) SS and Group (2) SS) are restricted to fall within the same Y consecutive slots   + Option B     - For Group (1) SS       * A SS can be configured to be within Y consecutive slots within a slot group of X slots       * The Y consecutive slots can be located anywhere within the slot group of X slots       * The location of the Y consecutive slots within the slot group of X slots is maintained across different slot groups       * BD attempts for all Group (1) SSs are restricted to fall within the same Y consecutive slots     - For Group (2) SS       * A SS can be configured to be anywhere within a slot group of X slots   + Option C     - For Group (1) SS       * A SS can be configured to be within Y consecutive slots within a slot group of X slots       * The Y consecutive slots can be located anywhere within the slot group of X slots       * The location of the Y consecutive slots within the slot group of X slots is maintained across different slot groups       * BD attempts for all Group (1) SSs are restricted to fall within the same Y consecutive slots     - For Group (2) SS       * A SS can be configured to be anywhere within a slot group of X slots       * The location of the SS within the slot group of X slots is maintained across different slot groups   + Option A-rev1     - A SS can be configured to be within Y consecutive slots within a slot group of X slots; the Y consecutive slots can be located anywhere within the slot group of X slots     - The location of the Y consecutive slots within the slot group of X slots is maintained across different slot groups     - BD attempts for all SS sets (Group (1) SS and Group (2) SS) are restricted to fall within the same Y consecutive slots     - FFS: Where BD attempts for Group (2) SS occur, e.g.       * Enhancement 1: Changing the default CSS configuration, such that the interval between neighbouring PDCCH monitoring locations is X slots instead of 1 slot [FL Note: Seems only necessary if the UE only supports Y=1]       * Enhancement 2: Introducing an offset n, applicable to both Group 1 and Group 2 SS     - To be decided in RAN1#106bis-e or RAN1#107-e       * Supported values of Y         + Option 1: Y=1 slot and optionally as well Y=X/2 consecutive slots         + Option 2: both Y=1 slot and Y=X/2 consecutive slots         + Option 3: both Y=1 slot and Y=X/2 consecutive slots are supported, FFS a default Y or which Y is mandatory/optional       * Which OFDM symbols can be configured for monitoring within the Y slot(s) (i.e., SS parameter *monitoringSymbolsWithinSlot*)   + Option A-FL1     - For Group (1) SS       * A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots         + FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity       * The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring         + FFS: Details of UE procedure for time offset determination, e.g., MAC-CE activation of a new TCI state associated with Group (2) SSs       * The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)       * BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots     - For Group (2) SS       * A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots       * The location of the YGroup2 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring       * The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)       * YGroup2 =max(2, YGroup1) [Ericsson: YGroup2 =2]     - The reported capability indicates the BD/CCE budget within max(2, YGroup1) slots per slot group     - To be decided in in RAN1#106bis-e or RAN1#107-e       * Supported values of YGroup1         + Option 1: YGroup1=1 slot and optionally as well YGroup1=X/2 consecutive slots         + Option 2: both YGroup1=1 slot and YGroup1=X/2 consecutive slots         + Option 3: both YGroup1=1 slot and YGroup1=X/2 consecutive slots are supported, FFS a default YGroup1 or which YGroup1 is mandatory/optional       * Which OFDM symbols can be configured for monitoring within the YGroup1/YGroup2 slot(s) (i.e., SS parameter *monitoringSymbolsWithinSlot*)       * SS dropping in case n0 changes (to avoid back-to-back monitoring exceeding the capability)   + Option B-rev1     - The reported capability indicates the BD/CCE budget within X slots     - For Group (1) SS       * A SS can be configured to be within Y consecutive slots within a slot group of X slots       * The location of the Y consecutive slots can be anywhere within a slot group of X slots         + FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity, and configured time offset within a slot group of X slots       * The location of the Y consecutive slots within a slot group of X slots is maintained across different slot groups       * BD attempts for all Group (1) SSs are restricted to fall within the same Y consecutive slots     - For Group (2) SS       * A SS can be configured as per Rel-15, and monitoring locations with respect to slot groups are unrestricted       * BD attempts for Group (2) SSs occur in slots with index n0 and n0 + 1 as per Rel-15     - To be decided in in RAN1#106bis-e or RAN1#107-e       * Supported values of Y         + Option 1: Y=1 slot and optionally as well Y=X/2 consecutive slots         + Option 2: both Y=1 slot and Y=X/2 consecutive slots         + Option 3: both Y=1 slot and Y=X/2 consecutive slots are supported, FFS a default Y or which Y is mandatory/optional       * Which OFDM symbols can be configured for monitoring within the Y slot(s) (i.e., SS parameter *monitoringSymbolsWithinSlot*)     - FFS: How to avoid back-to-back BD across slot groups   + Option B-FL1     - The reported capability indicates the BD/CCE budget within X slots     - For Group (1) SS       * A SS is configured to be within Y consecutive slots within a slot group of X slots       * The location of the Y consecutive slots can be anywhere within a slot group of X slots         + FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity, and configured time offset within a slot group of X slots       * The location of the Y consecutive slots within a slot group of X slots is maintained across different slot groups       * BD attempts for all Group (1) SSs are restricted to fall within the same Y consecutive slots     - For Group (2) SS       * A SS is configured as per Rel-15, and monitoring locations with respect to slot groups are unrestricted       * BD attempts for Group (2) SSs occur in slots with index n0 and n0 + 1 as per Rel-15     - To be decided in in RAN1#106bis-e or RAN1#107-e       * Supported values of Y         + Option 1: Y=1 slot and optionally as well Y=X/2 consecutive slots         + Option 2: both Y=1 slot and Y=X/2 consecutive slots         + Option 3: both Y=1 slot and Y=X/2 consecutive slots are supported, FFS a default Y or which Y is mandatory/optional       * Which OFDM symbols can be configured for monitoring within the YGroup1/YGroup2 slot(s) (i.e., SS parameter *monitoringSymbolsWithinSlot*) |

#### First round discussion

Companies are requested to review the following available suggestions and comment if they see any of these as a potential way forward.

**Original part labelled as FFS in the RAN1#106bis-e agreement:**

* + For Group (1) SS
    - A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots
    - The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots
    - The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)
    - BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots
  + For Group (2) SS
    - A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots
    - The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)
  + The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group
  + Support the following values of YGroup1 and YGroup2
    - For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1,[1 or 2])
    - For X=4: (YGroup1,YGroup2) = (2,2), (1,[1 or 2])
    - For X=2: (YGroup1,YGroup2) = (1,[1 or 2])
  + Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS
  + Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS

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| **Company** | **Comment** |
| Xiaomi | We are generally fine with the proposal. But would like to understand what is the intention for YGroup2=1? |
| Qualcomm | We don’t support the proposal. Allowing (semi-)dynamic changes (other than RRC reconfiguration) of Group (1) MOs based on n0 is a new behavior and fundamentally different from the existing PDCCH monitoring procedure. Thus, it may have large spec impacts compared to Options A and B. |
| Transsion | We can accept it as a way forward. Regarding the value of YGroup2, we prefer YGroup2=2 to maintain the behavior of R15. |
| Nokia, NSB | We can support this proposal.  For the values in brackets, we think that YGroup2 should always be 2.  Then, we think that the number of capabilities can be reduced. We think that (YGroup1,YGroup2) = (1,2) for cases with X=4 and X=8 does not add much value. Based on that we propose to support only the following combinations:   * For X=8: (YGroup1,YGroup2) = (4,2), (2,2) * For X=4: (YGroup1,YGroup2) = (2,2) * For X=2: (YGroup1,YGroup2) = (1,2). |
| MediaTek | We share the same view with Qualcomm. We had at least the following concerns if the concept of n0 is adopted in the spec:   1. The legacy SS set configuration slot offset definition will need to be changed accordingly. 2. Many details on how to align two groups need to be discussed. For example, how to shift the initial Y slots based on the offset n0 such that the updated Y slots will still be confined within a slot-group needs further discussion. (For example, assume all the SS sets are initially confined within the first two slots of a slot-group. If the Type-0 CSS monitoring is changed to the last slot of a slot-group, then how UE aligns the initial two monitoring slots with the updated Type-0 CSS monitoring in the last slot within a slot-group needs further discussion) 3. The significance of Type-0 CSS is debatable in connected mode. Changing all the SS sets based on Type-0 CSS monitoring behavior updating is not desirable for the system design.   Due to the limited discussion time, we should focus on the solution which can be completed within 1 meeting. The proposal with n0 offset has the least chance to achieve the goal based on our understanding. Furthermore, this new concept of n0 offset is new to spec and many corner cases discussion might be needed in the future, which is not desirable for the only PDCCH monitoring in 60GHz. Therefore, we prefer to focus on OptionA or Option B-rev1 and discuss which one can be acceptable and completed with minimized spec impact.  In our view, the only difference of OptionA and Option B-rev is the handling of SS#0 adaptation due to UE mobility. To move forward, we suggest to adopt OptionA as a baseline and introduce a capability for handling SS#0 in any slot within a slot-group (For the UEs supporting OptionA, PDCCH monitoring will always be confined within a Y slots but with the risk of reconfiguration, if needed. For UEs supporting OptionB, implementation needs to consider back-to-back monitoring and power consumption issue but there is no need for reconfiguration due to Type-0 CSS monitoring slots adaptation) |
| Panasonic | We support this proposal in general. Similar to Xiaomi, it is not clear to us the intention of the fourth sub-bullet (i.e. supported combination of YGroup1 and YGroup2 for X=8, 4, and 2). Does it mean that UE reports both values of YGroup1 and YGroup2 ? Since YGroup2 is used for cell-common information, it doesn’t seemingly make sense for individual UE to report different YGroup2 values, because for the broadcast information, network has to consider the worst-capable UE. Therefore, we suggest to define YGroup2 =2 slots for all UEs, which is also more consistent with the third sub-bullet.  This proposal has been an outcome of extensive discussion in the previous meeting. We suggest opposing companies to further work on this proposal instead of starting something new. |

**Huawei (R1-2110828):**

1. ***For multi PDCCH monitoring capability with X-slot group, UE can report the capability to support YGroup1 aligned with YGroup2 within X-slot (option A without further enhancement points) or YGroup1 independent of YGroup2 (option B).***

* ***For Group 1) SS***
* ***SS is configured to be within YGroup1 consecutive slots within a slot group of X slots. The YGroup1 consecutive slots can be located anywhere within the slot group of X slots.***
* ***The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups***
* ***For Group 2) SS***
* ***Group 2) SS is configured to be within YGroup2 consecutive slots within a slot group of X slots. The YGroup2 consecutive slots can be located anywhere within the slot group of X slots.***
* ***The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups.***

1. ***Support the following values of YGroup1 and YGroup2***

* ***YGroup1 = X/2 or 1;***
* ***YGroup2 = 2.***

1. ***Corresponding to FG3-1 in Rel-15, PDCCH monitoring occasion restricted in the first 3 OS of each of the YGroup1 slots in the X-slot group should be supported as a basic feature for type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS.***
2. ***Corresponding to FG3-1 in Rel-15, PDCCH monitoring occasion can be in any symbol(s) of YGroup2 slots for Type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS.***

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| **Company** | **Comment** |
| Nokia, NSB | Proposal 1:   * We prefer formulation according to “FFS in the RAN1#106bis-e agreement”.   + If YGroup1 and YGroup2  are defined, it makes sense to make them overlapping * Our 2nd preference is Option B   Proposals 2-4:   * We agree with *YGroup2 = 2* * We agree with Proposal 4 * We’re ready to agree Proposal 3 for the cases when *YGroup1 = X/2* * At the same time, we think that Proposal 3 is limiting the scheduling flexibility too much for the cases when *YGroup1 = 1* |
| Panasonic | Proposal 1: we are ok.  Proposal 2: we support.  Proposals 3 and 4: from our point of view, in order to balance the UE complexity and network scheduling flexibility, UE should be able to support two spans of MOs per slot of Y, with each span having the maximum 3 symbols in duration. This allows network to transmit Group(1) SS and Group(2) SS at different symbols of a slot to the UE. The spans can be located in any symbol of a slot. The separation of the two spans is subject to UE capability. |

**vivo (R1-2110999):**

* **Option 1: All SSs are restricted in Y consecutive slots within each X-slot group**
  + **Option 1b (1st preference): Y=1 is mandatory capability and Type 0 PDCCH monitoring is changed to slot  from slot (, +1) as in NR Rel-15/16**
* **Option 2: Group (1) SSs are restricted in YGroup1 consecutive slot and Group (2) SSs are restricted in YGroup2 consecutive slot within each X-slot group where YGroup1 slots overlap with YGroup2 slots**
  + **Option 2a (2nd preference): YGroup2= 2 is mandatory capability and follow legacy Type 0 PDCCH monitoring as in NR Rel-15/16**
  + **Option 2b (1st preference): YGroup2=1 is mandatory capability and Option 1b: Y=1 is mandatory capability and Type 0 PDCCH monitoring is changed to slot  from slot (, +1) as in NR Rel-15/16**

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| **Company** | **Comment** |
| Qualcomm | We are okay with Option 1, but we don’t support Option 2 (due to the same reason that we stated above for the original FFS of RAN1 #106bis-e). |
| Nokia, NSB | Option 1b, Option 2b: we don’t support these options. We think CSS should be untouched.  Option 2a: we support this option |

**ZTE (R1-2111075):**

**Proposal 2: Align Group (1) SS with Group (2) CSS set in the location of Y slots.**

* **A SS is configured to be within Y consecutive slots within a slot group of X slots**
* **The location of the Y consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**
* **The location of the Y consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) SS monitoring**

**Proposal 3:**

* **The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group**
* **Support the following values of YGroup1 and YGroup2**
  + **For X=8: (YGroup1,YGroup2) = (4,2), (3,2), (2,2), (1,2)**
  + **For X=4: (YGroup1,YGroup2) = (2,2), (1, 2)**

**Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS**

**Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS**

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| **Company** | **Comment** |
| Qualcomm | We don’t support (semi-)dynamic change of YGroup1 location based on n0. Thus, we don’t support this proposal. |
| Nokia, NSB | We can support these proposals. We think that certain (YGroup1,YGroup2) -combos, esp. (3,2) are not needed. |
| Panasonic | Proposal 2: we are ok. But since it is covered by the original FFS of previous meeting, it is sufficient to discuss original FFS part instead of this proposal.  Proposal 3: It seems the modification compared to the original FFS of previous meeting is to mandate YGroup2 = 2? If so, we support this proposal. |

**Nokia (R1-2111196):**

***Proposal 3*:** *YGroup2 within a slot group overlaps with the (two) slots containing Type0\_PDCCH*

***Proposal 4*:** *Location of YGroup1 is selected among the candidate locations fully overlapping with YGroup2*

***Proposal 5*:** *UE needs to re-evaluate the validity of location for YGroup1 (i.e. overlap with YGroup2) when the location of YGroup2 changes:*

* *When a new location for YGroup1 is needed, it can be selected e.g. according to the smallest offset that results in full overlap between YGroup1 and YGroup2 .*

***Proposal 6*:** *Support the following values of* YGroup1 *and* YGroup2

* + For X=8: (YGroup1,YGroup2) = (4,2), (2,2)
  + For X=4: (YGroup1,YGroup2) = (2,2)
  + For X=2: (YGroup1,YGroup2) = (1,2).

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| **Company** | **Comment** |
| Qualcomm | We don’t support (semi-)dynamic change of YGroup1 location based on n0. Thus, we don’t support this proposal. |
| Nokia, NSB | We think this is everything needed to get a working solution on top of the RAN1#106bis-e agreement (under FFS) |
| Panasonic | We support the proposals, except the Proposal 6, where Ygroup1 = 1 can be also considered (on the other hand, we support a single value of Ygroup2=2) |

**CATT (R1-2111242):**

***Proposal 1: The FFS part of RAN1#106bis-e is closed and the following is agreed in addition to the previous agreement:***

* ***The reported capability indicates the BD/CCE budget within Y consecutive slots in each slot group***
  + ***For reporting the BD/CCE budget, the UE may assume that the location of the Y consecutive slots within the X slots is maintained across different slot groups***
  + ***UE reports its BD/CCE budget for Y=1 slot and Y=X/2 consecutive slots***
* ***A SS can be configured to be within Y consecutive slots within a slot group of X slots; the Y consecutive slots can be located anywhere within the slot group of X slots***
  + ***The location of the Y consecutive slots within the slot group of X slots is maintained across different slot groups***
  + ***BD attempts for all SS sets are restricted to fall within Y consecutive slots***

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| **Company** | **Comment** |
| Nokia, NSB | We think that Group(1) SS and Group(2) SS need to be considered separately   * We prefer formulation according to “FFS in the RAN1#106bis-e agreement”.   Our 2nd preference is Option B |
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**Ericsson (R1-2111464):**

We propose to modify the definition of X-slot group grid as follows:

1. For operation with 480/960 kHz SCS multi-slot PDCCH monitoring with slot group size of X, the UE determines that a slot with index in a frame with index is the start of a X-slot group if

where is the slot group grid offset. With this X-slot group grid definition, the monitoring slot(s) for all search spaces are always at the beginning of a slot group and back-to-back PDCCH processing overloading is avoided.

1. For a 480/960 kHz SCS serving cell operating with multi-slot PDCCH monitoring with slot group size of X, the slot group grid offset is determined as

where is the index of the first monitoring slot for the type0 PDCCH on the PCell/PSCell if the PCell/PSCell operates with multi-slot PDCCH monitoring and if the PCell/PSCell does not operate with multi-slot PDCCH monitoring.

1. For operation with 480/960 kHz SCS multi-slot PDCCH monitoring with slot group size of X, the UE determines that a PDCCH monitoring occasion for search space in Group (1) is in slot with index in a frame with index if

where , , and are the configured periodicity, offset and duration of the search space in terms of X-slot groups, and is the slot group grid offset.

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| **Company** | **Comment** |
| Qualcomm | We don’t support (semi-)dynamic change of YGroup1 location based on n0. Thus, we don’t support this proposal. |
| Nokia, NSB | Given that this is the last meeting, we think that the decision should be based on the existing options   * We prefer formulation according to “FFS in the RAN1#106bis-e agreement”. * Our 2nd preference is Option B   We think that these proposals don’t bring substantial benefits compared to the existing solutions. |
| Panasonic | We understand that the above set of proposals are aligned with the principle of the original FFS of the previous meeting. Since the original FFS is getting close to consensus in our impression, to keep the original formulation is preferred. On the other hand, we are open to further discuss this new formulation if it can help the progress. |

**Intel (R1-2111484):**

**Proposal 2:** For Type0A/2 CSS sets configured with searchSpaceID non-zero

* It can be handled by Option B, i.e., Group (2) SS can be anywhere in a X-slot group.
* If other options except Option B is used, FFS how to align the slot offset of the MOs of Type0A/2 CSS sets and the slot offset of Type0 CSS set for the same SSB.

**Proposal 3:** Type1 CSS sets without dedicated RRC configuration is handled differently from other CSS/USS sets with dedicated RRC configuration.

**Proposal 4:** For multi-slot PDCCH monitoring capability

* It is preferred to adopt Option B, i.e. Group (2) SS can be anywhere in a X-slot group.
* If Option B is not agreeable, Option B-rev1, A-FL1 or the FFS in the agreements can be further discussed. Special handling for Type0A/2 CSS sets configured with searchSpaceID non-zero is necessary

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| **Company** | **Comment** |
| Nokia, NSB | Given that this is the last meeting, we think the decision should be based on the existing options   * We prefer formulation according to “FFS in the RAN1#106bis-e agreement”.   Our 2nd preference is Option B |
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**Samsung (R1-2111726):**

**Proposal 1: Support Option A for multi-slot PDCCH monitoring:**

* **Y=1 is mandatory, and Y=X/2 is optional;**
* **UE only monitors one slot for Type0-PDCCH:**
  + **Alt 1: the one slot is slot for all cases;**
  + **Alt 2: the one slot is slot for and , and configurable between slot and for**
* **No need to introduce the time offset for aligning Group (1) and Group (2) SS.**

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| **Company** | **Comment** |
| Qualcomm | We are generally fine with the proposal. |
| Nokia, NSB | We do not support this proposal. We think CSS should be untouched. |
| Panasonic | We don’t support the proposal since it changes fundamentally the legacy Type-0 PDCCH monitoring behavior. |

**NTT DOCOMO (R1-2112097):**

**Proposal 2: Search space configuration for multi-slot PDCCH monitoring capability can be as follows (modified Option A-FL1 in the discussion of RAN1#106bis-e meeting):**

* **For Group (1) SS**
  + **A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots**
    - **FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity**
  + **The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring**
    - **FFS: Details of UE procedure for time offset determination, e.g., MAC-CE activation of a new TCI state associated with Group (2) SSs**
  + **The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**
  + **BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots**
* **For Group (2) SS**
  + **A SS is configured to be within YGroup2 = 2 consecutive slots within a slot group of X slots, i.e., slots n0 and n0 + 1 as per Rel-15**
  + **~~The location of the Y~~~~Group2~~ ~~consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring~~**
  + **The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**
  + ~~Y~~~~Group2~~ ~~=max(2, Y~~~~Group1~~~~) [Ericsson: Y~~~~Group2~~ ~~=2]~~
* **The reported capability indicates the BD/CCE budget within max(2, YGroup1) slots per slot group**
* **Supported values of YGroup1**
  + **YGroup1=1 slot and optionally as well Y=X/2 consecutive slots**
* **OFDM symbols can be configured for monitoring within the Y slot(s) is** 
  + **For Group (1) SS: first 3 symbols as mandatory UE capability and any OFDM symbols depending on the UE capability**
  + **For Group (2) SS: any OFDM symbols**
* **FFS: SS dropping in case n0 changes (to avoid back-to-back monitoring exceeding the capability)**

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| **Company** | **Comment** |
| Qualcomm | We don’t support (semi-)dynamic change of YGroup1 location based on n0. Thus, we don’t support this proposal. |
| Nokia, NSB | We could support this proposal.  W.r.t. monitoring symbols within Y slots, we think that the scheduling flexibility is limited too much for the cases when *YGroup1 = 1.* Hence, for this scenario, more flexibility is needed for the monitoring symbols. |
| Panasonic | We support the proposal in general. For the OFDM symbols to be monitored within Y slots, UE should be able to support two spans of MOs per slot of Y, with each span having the maximum 3 symbols in duration. This allows network to transmit Group(1) SS and Group(2) SS at different symbols of a slot to the UE. The spans can be located in any symbol of a slot. The separation of the two spans is subject to UE capability. |

**Qualcomm (R1-2112204):**

Regarding the discussion on whether and how to align monitoring occasions of USS and CSS, our preference is still Option A. However, in order make a progress, we are willing to compromise with Option B if it is properly modified to reflect the proposals in this contribution. Consolidating the discussion in the previous sections, the following revision of Option B is suggested as a compromise, where the changes from the previous version in RAN1 #106bis-e are marked in red font.

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| * Option B-rev2   + The reported capability indicates the BD/CCE budget within X slots   + For Group (1) SS     - A SS can be configured to be within YGroup1 consecutive slots within a slot group of X slots     - The location of the YGroup1 consecutive slots can be anywhere within a slot group of X slots       * FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity, and configured time offset within a slot group of X slots     - The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups     - BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots   + For Group (2) SS     - A SS can be configured to be within YGroup2 consecutive slots within a slot group of X slots     - The location of the YGroup2 consecutive slots within a slot group of X slots is based on slot index n0 in association with an SSB as per Rel-15     - BD attempts for Group (2) SSs are restricted to one slot per slot group of X slots, i.e., YGroup2 = 1 slot       * Alt 1) slot n0 and slot n0+X       * Alt 2) slot n0 only   + The maximum number of monitored slots for PDCCH in a slot group is restricted to YTotal     - YTotal is per UE capability     - YGroup1+YGroup2 ≥ YTotal ≥ YGroup1 ≥ YGroup2 = 1 slot     - If the number of slots included in at least one of YGroup1 and YGroup2 exceeds YTotal, one of Group (1) and Group (2) shall be prioritized   + Supported the following values of Y’s     - For X = 8: (YGroup1, YGroup2, YTotal) = (1, 1, 1) and optionally (1, 1, 2), (4, 1, 4), (4, 1, 5)     - For X = 4: (YGroup1, YGroup2, YTotal) = (1, 1, 1) and optionally (1, 1, 2), (2, 1, 2), (2, 1, 3)     - For X = 2: (YGroup1, YGroup2, YTotal) = (1, 1, 1) and optionally (1, 1, 2) |

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| **Company** | **Comment** |
| Qualcomm | We support this proposal as a compromise of Option A and Option B (and some of their variants). It basically maintains the features of Option B and allows the MOs for Group (1) and Group (2) to be at different locations in a slot group. However, as we argued in our contribution, even for Option B, retaining the legacy SS set #0 design of two consecutive slot monitoring brings up many issues, including back-to-back PDCCH monitoring, excessive CSS BD/CCE assignment (i.e., twice that of slot-based PDCCH monitoring), and limited CSS configuration flexibility (to avoid BD/CCE over-budget). Thus, the restriction of YGroup2 = 1 slot is added. This may also require an enhancement of SS set #0 but, as many companies including us proposed in their contributions, it should be straightforward. |
| Nokia, NSB | We don’t support this proposal. We think that CSS should be untouched. |

### Issue A1-2: Definition/applicability of monitoring capability

#### First round discussion

Please comment if the following proposals are agreeable (vivo, R1-2110999):

Proposal 3: For NR Rel-17 UEs, PDCCH monitoring capability is defined per BWP and configuration of 480K/960K SCS for a BWP implies multi-slot-based capability for that BWP.

Proposal 4: PDCCH monitoring capability for a serving cell is the capability for its active BWP or configured first active BWP when it is deactivated.

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| **Company** | **Comment** |
| Xiaomi | Proposal 3,  If it is the majority view not to support single slot PDCCH monitoring, we are OK with Proposal 3.  Proposal 4,  Generally fine with the proposal. |
| Transsion | We are fine with Proposal 3 and Proposal 4. |
| Nokia, NSB | Taking into account that the WI is ending soon, we think that supporting only multi-slot based capability for 480/960 kHz SCS is sufficient. |

### Issue A1-3: Support of single-slot / multi-slot PDCCH monitoring

#### First round discussion

Please comment if the following proposal is agreeable.

Proposal: Single-slot PDCCH monitoring is not supported for SCS 480/960 kHz.

Note: Such an agreement implies that multi-slot monitoring is applicable already for UEs operating in RRC\_IDLE in FR2-2 with 480/960 kHz.

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| **Company** | **Comment** |
| Xiaomi | We are more inclined to have single-slot/multi-slot PDCCH monitoring as UE capability, and single slot PDCCH monitoring as a default capability. However, If it is the majority view not to support single slot PDCCH monitoring, we will be OK with this Proposal |
| Transsion | We are fine with this proposal. Just as many companies have mentioned, for single-slot PDCCH monitoring, the BD/CCE budget is small, which will impact the flexibility of PDCCH scheduling. |
| Nokia, NSB | Taking into account that the WI is ending soon, we think that supporting only multi-slot based capability for 480/960 kHz SCS is sufficient.  We also think that multi-slot monitoring can be supported already for RRC\_Idle. |
| Panasonic | We support the single-slot monitoring as an optional capability for SCS 480/960 kHz SCS. |

## Topic A2: Search Space Configuration/Enhancement

### Issue A2-1: Periodicity, offset, duration configuration for multi-slot monitoring

#### First round discussion

Please comment if the following proposal is agreeable (Huawei, R1-2110828).

* ***For search space set configuration for multi-slot PDCCH monitoring, the unit of “periodicity” should be changed to X slots, with default value X=4 for 480 kHz and X=8 for 960 kHz.***
* ***For search space set configuration for multi-slot PDCCH monitoring, the parameter “offset” should be re-interpreted as follows:***
  + ***If the Group (1) SS is determined independently of Group (2) SS, which is preferred, then the unit of “offset” is changed to X slots, with default value X=4 for 480 kHz and X=8 for 960 kHz, and an additional slot level offset or extension of monitoringSymbolsWithinSlot is required if monitoring occasions are within the Y>1 slots in an X-slots.***
* ***For search space set configuration for multi-slot PDCCH monitoring, the unit of “duration” should be changed to X slots, with default value X=4 for 480 kHz and X=8 for 960 kHz SCS.***

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| **Company** | **Comment** |
| Xiaomi | **For the first bullet,**  Currently, there are already 4/8/16 slots periodicity in spec, maybe it is more natural to add other appropriate periodicity values, such as 32/64/128 slots  **For the second bullet,**  Our understanding is “offset” is used to define which slot a periodicity start. There is no need to change the unit of “offset” to X slots, it can still keep one slot unit.  **For the third bullet,**  Agree. |
| Qualcomm | We don’t support the proposal. Re-interpreting the value of existing higher layer parameters just for a certain SCS and a certain release seems against the fundamental principle of scalable numerology of NR. In our view, when a feature is extended in a new release, adding new configuration parameters and values (e.g., monitoringSlotPeriodicityAndOffset-r17, duration-r17, etc.) or introducing some restriction to the configurable values of existing parameters (e.g., UE only expects that the SS set periodicity is an integer multiple of X) is more common practice in NR.  Furthermore, for the proposal, it seems necessary that the gNB should indicate the unit ‘X’ to the UE, if the UE supports multiple X values. However, as Rel-16 span-based PDCCH monitoring, we don’t think an explicit indication of the X value is necessary. Instead, the X values, which is compliant with one of the (X,Y) combinations that the UE reported as its capability, can be implied by the search space set configuration, i.e., from the periodicity and MOs. |
| Transsion | Regarding the first bullet, we are fine with this interpretation. Since single-slot PDCCH monitoring is not preferred by majority companies, most of the values in the periodicity IE are invalid. Extending the parameter of period to an integer multiple of X is a straightforward way to address the SS configuration under multi-slot PDCCH monitoring. |
| Nokia, NSB | We need to first progress Topic A1. After that, the rest will follow. |
| Panasonic | We share the similar view as Qualcomm. |

Additionally, please comment if the following proposal is agreeable (CATT, R1-2111242).

***Add a new bitmap monitoringSlotWithinMulti-slot indicating the slot that the search space exists within the multi-slot.***



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| **Company** | **Comment** |
| Xiaomi | We are open to introduce *monitoringSlotWithinMulti-slot.* |
| Qualcomm | This proposal is only relevant to Y>1 slot. Since we think Y = 1 slot should be the mandatory capability, while Y > 1 is optional, we don’t think this is an urgent issue. However, we are generally open to discuss this issue: In our view, there seem to be different ways to achieve the same goal, e.g., 1) introducing a single bitmap of size 14·X, or 2) adding a slot-level bitmap as in the proposal. |
| Nokia, NSB | We need to first progress Topic A1. After that, the rest will follow. |
| Panasonic | We share the view that this issue can be decided later, and the proposal is one of the alternatives. For example, if the periodicity of SS is integer number of X, such slot-level bitmap indication is not needed. |

### Issue A2-2: CORESET duration

#### First round discussion

Please comment if the following proposal is agreeable (ZTE, R1-2111075).

**Consider a duration of more than 3 OFDM symbols for PDCCH with 480/960 kHz SCS in Rel-17 NR above 52.6 GHz.**

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| **Company** | **Comment** |
| Xiaomi | Support. |
| Qualcomm | Throughout the SI and WI phases of FR2-2, we haven’t seen enough justification for the CORESET enhancement with more than 3 symbols (e.g., for coverage or reliability enhancement). Considering the remaining time, we think this issue should be deprioritized. |
| Transsion | We think this issue should be deprioritized. |
| Nokia, NSB | Agree with Qualcomm’s view |
| Panasonic | Same view as Qualcomm. |

### Issue A2-3: SS set group switching

#### First round discussion

Many companies support SSSG switching for 480/960 kHz, which seems to be a natural extension of the Rel-16 functionality, so it may not need explicit agreement. An open item is whether SSSG switching can support switching between PDCCH multi-slot monitoring periodicities (and per-slot monitoring, if supported).

Without agreeing corresponding minimum switching times the switching feature would not be available for SCS greater than 60 kHz kHz.

Please comment (if any) on the following consideration by NTT DOCOMO.

**SSSG switching time for UE processing capability should be specified for 120/480/960 kHz SCS.**

**Scaling based on the one with 60 kHz SCS can be baseline (i.e. larger than such values should be avoided)**

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|  | Minimum value for UE processing capability 1 [symbol] |
| 0 | 25 |
| 1 | 25 |
| 2 | 25 |
| 3 | 50 |
| 5 | 200 |
| 6 | 400 |

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| **Company** | **Comment** |
| Xiaomi | Agree in general. but also open to discuss other possible values. |
| Qualcomm | In Rel-16, Pswitch for Cap2 is based on SPS release timeline of Cap1, i.e, N=10 for μ=0, N=12 for μ=1, N=22 for μ=2, and N=25 for μ=3. Therefore, although Cap2 is not supported for μ=3, the projected reference value of Pswitch for μ=3 would be the same as the Cap1 SPS release timeline for μ=3, i.e., 25 symbols. Then, the suggested value for μ=3 in the table, 50 symbols, is twice as large as the projected value. Considering that the ratio of Pswitch values between Cap1 and Cap2 in Rel-16 tends to decrease with SCS (i.e., 25/10 for μ=0, 25/12 for μ=1, and 25/22 for μ=2), the suggested number of 50 symbols for μ=3 seems excessive.  In our view, around 28~30 symbols would be more reasonable for μ=3, and the number for μ=3 may be directly scaled with SCS for μ=5 and 6 (i.e., 112~120 symbols for μ=5 and 224~240 symbols for μ=6). |
| Transsion | We are open to discuss other values. |
| Nokia, NSB | Agree in principle. Agree with QC that we should have a reasonable value for 120 kHz SCS first, and obtain values for 480/960 kHz SCSs based on scaling. |

## Topic A3: BD Budget/Dropping

### Issue A3-1: Budget of PDCCH candidates and non-overlapped CCEs for 480/960 kHz

#### First round discussion

Can we agree on the following:

**Proposal:**

* **The following limits apply for multi-slot monitoring within X slots**
  + **The maximum number of monitored PDCCH candidates per X=4 slots for a DL BWP with 480 kHz SCS configuration for a single serving cell is 20.**
  + **The maximum number of monitored PDCCH candidates per X=8 slots for a DL BWP with 960 kHz SCS configuration for a single serving cell is 20.**
  + **The maximum number of of non-overlapped CCEs per X=4 slots for a DL BWP with 480 kHz SCS configuration for a single serving cell is 32.**
  + **The maximum number of of non-overlapped CCEs per X=8 slots for a DL BWP with 960 kHz SCS configuration for a single serving cell is 32.**
* **Note: Search spaces will be additionally confined within Y slots, see corresponding discussion in Issue A1**

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| **Company** | **Comment** |
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### Issue A3-2: PDCCH candidate dropping for 480/960 kHz

#### First round discussion

Previous discussion n RAN1#106bis-e and submitted document show a preference to agree on the following proposal (based on NTT DOCOMO, R1-2112097):

**Proposal:**

* **SS set overbooking can be allowed with multi-slot PDCCH monitoring capability same as the current specification, i.e., SS set overbooking is allowed for USS in PCell and PSCell and UE expects no overbooking for CSS and CSS/USS in SCell.**
* **The dropping rule for multi-slot PDCCH monitoring capability is the same as the current specification, i.e., a UE drops UE specific search space set(s) with higher index when SS sets are overbooked and expects there is no overbooking for CSS sets.**
  + **If a USS set is configured across multiple slots in a slot group, the USS set should be checked and dropped as a whole.**
* **Additional dropping rules are not precluded (e.g. when UE moves between beams)**

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| **Company** | **Comment** |
| Xiaomi | **For the first bullet,**  Agree  **For the second bullet**,  Our preference is to drop the search spaces in the latest slot (or several latest slots) of the Y slots, in order to save power and UE can switch to sleep as soon as possible.  We don’t see any benefit of adopting the same rule as R16 to drop specific search space set(s) with higher index, it was designed for single slot PDCCH monitoring. |
| Qualcomm | We support the proposal. |
| Transsion | We support the proposal. |
| Nokia, NSB | We support the proposal.  It might be good to add that dropping is done with the granularity of a slot group (instead of a slot). |
| Panasonic | We support the proposal. |

### Issue A3-3: PDCCH candidate dropping when MOs change

#### First round discussion

Please comment on the following proposal (Lenovo, R1-2111642).

**Proposal:**

***For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, then dropping of Group(1) SS MOs and/or Group(2) SS MOs in the slot where the shift is first applied should be supported***



**Figure 2: Example of dropping first Group(1) SS MO (assuming no shifting) to avoid back-to-back monitoring when n0 changes**

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| **Company** | **Comment** |
| Xiaomi | If the majorities think back to back monitoring is really a problem, How to solve the issues should be discussed. But our initial thinking is, if n0 changes(due to beam change), gnB may be able to configure a suitable group(2) SS in advance? |
| Qualcomm | We think this proposal is dependent on the outcome of Topic A1. Thus, it should be deferred until the discussion of Topic A1 is finalized. |
| Transsion | We should wait for the outcome of Topic A1. For the current options in A1, only option B may suffer back-to-back issue, however, form our perspective, considering that the period of Group (2) SS is much longer compared to that of Group (1) SS, this issue is very weak. |
| Nokia, NSB | Agree with Qualcomm |
| Panasonic | This can be discussed later after Topic A1. Furthermore, we think Group(2) SS should be prioritized over Group(1) SS if dropping is applied. |

## Topic B: Multi-Beam Aspects

### Issue B-1: Beam-specific indication in DCI format 2\_0

Several contributions show the following proposal; however one company prefers to not discuss this enhancement as part of Release 17.

Please comment on the following proposal.

**Proposal: In DCI format 2\_0, the following parameters can be indicated in a beam-specific manner**

* **Remaining CO duration**
* **Available RB set**
* **Search space group switching**

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| **Company** | **Comment** |
| Xiaomi | For the first bullet,  It really depends on how to define COT. Whether it is per node or per beam, which we haven’t decided about it .  For the second/third bullet,  If directional LBT is adopted, it is possible to support per beam available RB set/SSGS. |
| Qualcomm | We support the proposal. |
| Transsion | We support the proposal. |
| Nokia, NSB | We support this proposal |

## Topic D: Multi-Cell Operation, Cross-carrier scheduling

### Issue D-1: Cross-carrier scheduling and multi-cell operation limitations

Discussion shows some support for a limitation along the following line, wth discrepancies for the value of k:

Cross-carrier scheduling of a cell within 52.6-71 GHz from/to a cell outside 52.6-71 GHz is supported, at least for |*μPDCCH* − *μPDSCH* | ≤ k.

Suggested values range from k=3 to k=5, or no imposed limit:

This topic had already been discussed in earlier meetings, however without a conclusion. It is noted that k=3 implies that cross-carrier scheduling between FR1 and FR2-2 is not supported.

#### First round discussion

Given earlier discussion and present contributions, FL suggest to decide between k=4 and k=5. In FL's understanding, a lack of consensus on this issue means that there is no cross-carrier scheduling limitation w.r.t. FRs/SCS (Alt 3 below).

**Please provide your comments on the following proposal:**

* **Cross-carrier scheduling of a cell within 52.6-71 GHz from/to a cell outside 52.6-71 GHz is only supported for |*μPDCCH* − *μPDSCH* | ≤ k. Decide between the following:**
  + **Alt 1: k=4**
  + **Alt 2: k=5**
  + **Alt 3: unlimited, i.e. cross-carrier scheduling is supported between any FR1 and any FR2 carriers.**

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| **Company** | **Comment** |
| Xiaomi | K value can be indicated as UE capability. |
| Transsion | Alt 3, and K value can be indicated via UE capability. |
| Nokia, NSB | We support Alt 3 |

# Contribution Details

The following sections show extracted discussion and proposals from the contributions submitted to this AI, by a pure subjective decision by the FL.

## Topic A1: Blind Decoding Capability, Multi-slot monitoring

List of issues, proposals, and suggestions for handling in the email discussion phase.

### R1-2110828 (Huawei, HiSilicon)

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| According to the previous agreements in RAN1#106-e and RAN1#106b-e, multi-slot PDCCH monitoring with X=4/8 is supported by default if UE report the capability to support the numerology of 480/960kHz SCS. If our understanding is correct, the BD/CCE budgets within an X-slot group is to be specified for a given SCS in TS38.213. If the additional capability were agreed by RAN1, e.g. X=4 for 960 kHz SCS, the corresponding BD/CCE budget would be specified as well in TS38.213. Thus, a UE does not need to report the BD/CCE budget separately but only its capability of whether to support multi-slot monitoring.  ***Observation 1: The BD/CCE budget corresponds to X-slot group should be specified in RAN1 spec. UE would only report the capability to support X-slot PDCCH monitoring with optional X value.***  In RAN1#106b-e, X=4 for 960 kHz SCS is agreed as an optional capability as well as the mandatory support of X=4/8 for 480/960 kHz SCS. As for X=2 for 480kHz SCS, it requires UE to monitor PDCCH every 2 slots which almost double monitoring load from that of 120kHz if same BD/CCE budget per 120kHz slot are assume for the 2-slot group. Otherwise, the BD/CCE budget is restricted to support higher AL if BD/CCE budget per 120 kHz slot is evenly distributed between two 2-slot groups. Moreover, there is no consensus on the value of Y. if Y=2 were supported finally, UE would be required to monitor PDCCH every slot. Hence, the usage of X=2 for 480 kHz is not clear and should be not supported in Rel-17.   1. ***The capability of X=2 for 480 kHz is not supported.*** 2. ***For multi PDCCH monitoring capability with X-slot group, UE can report the capability to support YGroup1 aligned with YGroup2 within X-slot (option A without further enhancement points) or YGroup1 independent of YGroup2 (option B).***  * ***For Group 1) SS*** * ***SS is configured to be within YGroup1 consecutive slots within a slot group of X slots. The YGroup1 consecutive slots can be located anywhere within the slot group of X slots.*** * ***The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups*** * ***For Group 2) SS*** * ***Group 2) SS is configured to be within YGroup2 consecutive slots within a slot group of X slots. The YGroup2 consecutive slots can be located anywhere within the slot group of X slots.*** * ***The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups.***  1. ***Support the following values of YGroup1 and YGroup2***  * ***YGroup1 = X/2 or 1;*** * ***YGroup2 = 2.***  1. ***Corresponding to FG3-1 in Rel-15, PDCCH monitoring occasion restricted in the first 3 OS of each of the YGroup1 slots in the X-slot group should be supported as a basic feature for type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS.*** 2. ***Corresponding to FG3-1 in Rel-15, PDCCH monitoring occasion can be in any symbol(s) of*** *YGroup2* ***slots for Type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS.*** |

### R1-2110873 (Futurewei)

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| If we just scale up the existing solution the answer is yes. However, if the monitoring opportunities extend for the duration of X slots the power saving advantage may be lots. Therefore, the monitoring opportunities would better be confined in a span of successive slots in X, named in the above agreement YGroup2. Where the span YGroup2 may start in any slot of X, and YGroup2 < X. Another controversial point during RAN1 discussions was the size of YGroup2. A size of 2 is compatible with existing implementation where the monitoring happens in n0 and n0+1. It also offers more flexibility. An argument against the size of 2slots was the possibility of having back-to-back allocations in two consecutive groups X that will be larger than the BD budget. One way to avoid it is to keep the YGroup2 span location the same in different groups X. However, this is not possible when the UE moves from one cell to another. Another possibility to avoid the over-budget situation is to allow YGroup2 smaller size of 1 slot, which can limit the total CSS monitoring occasions. This is a good choice especially for X=2.  **Proposal 1: Support the following values of YGroup1 and YGroup2**   * **For X=8: (YGroup1, YGroup2) = (4,2), (2,2), (1,2)** * **For X=4: (YGroup1, YGroup2) = (2,2), (1,2)** * **For X=2: (YGroup1, YGroup2) = (1,2)**   It was argued that when UE changes the location, the UE may change beams. It also was noticed that YGroup2 may be much less frequent (20ms), therefore may be even missing during a COT, which is limited to 5ms duration. Therefore, during a COT, because of the location change, a UE may need to start monitoring new locations for YGroup2 while monitoring the old locations for YGroup1. Preserving an offset between these two spans would allow UE to start monitoring new YGroup1 span without additional RRC configuration. YGroup1 may be different for different UEs and be staggered in time during the X slots pattern.  **Proposal 2: For the same size of group pattern X, the offset between the start of YGroup1 and YGroup2 should be maintained constant in the same cell in the absence of RRC configuration.**  **Proposal 3: The reported BD capabilities is done per X slots group as in the agreement. In other words, remove from the FFS part of the agreement:**   * + **The reported capability indicates the BD/CCE budget within Y = max(YGroup1, 2) slots per slot group**   Based on these arguments, we address the FFS part from the agreement above (RAN1# 106bis-e) and propose the following text based on the agreement, which basically remove the FFS and proposes the **YGroup1 and YGroup2** values.  **Proposal 4: Multi-slot PDCCH monitoring is based on slots within a slot group where:**   * **Each slot group consists of X consecutive slots**   + **Slot groups are consecutive and non-overlapping**   + **The start of the first slot group in a subframe is aligned with the subframe boundary**   + **The start of each slot group is aligned with a slot boundary**   + **Reporting the BD/CCE budget for X = 4/8 slots (for 480/960 kHz resp.) is mandatory (if UE supports the corresponding SCS), and is optional for X = [2]/4 slots (for 480/960 kHz resp.)** * **There is a common BD budget for all search spaces** * **For Group (1) SS**   + **A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots**   + **The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots**   + **The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**   + **BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots** * **For Group (2) SS**   + **A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots**   + **The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)** * **Support the following values of YGroup1 and YGroup2**   + **For X=8: (YGroup1, YGroup2) = (4,2), (2,2), (1,2)**   + **For X=4: (YGroup1, YGroup2) = (2,2), (1,2)**   + **For X=2: (YGroup1, YGroup2) = (1,2)**   **Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS**  **Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS**  **Observation 1: The above proposal implies that BD attempts for all SS sets for (1) are restricted to fall within the YGroup1 slots, BD attempts for all SS sets for (2) are restricted to fall within the YGroup2 slots.** |

### R1-2110999 (vivo)

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| Proposal 1: Consider the following options for further design of multi-slot PDCCH monitoring capability:   * **Option 1: All SSs are restricted in Y consecutive slots within each X-slot group**   + **Option 1b (1st preference): Y=1 is mandatory capability and Type 0 PDCCH monitoring is changed to slot  from slot (, +1) as in NR Rel-15/16** * **Option 2: Group (1) SSs are restricted in YGroup1 consecutive slot and Group (2) SSs are restricted in YGroup2 consecutive slot within each X-slot group where YGroup1 slots overlap with YGroup2 slots**   + **Option 2a (2nd preference): YGroup2= 2 is mandatory capability and follow legacy Type 0 PDCCH monitoring as in NR Rel-15/16**   + **Option 2b (1st preference): YGroup2=1 is mandatory capability and Option 1b: Y=1 is mandatory capability and Type 0 PDCCH monitoring is changed to slot  from slot (, +1) as in NR Rel-15/16**   Proposal 3: For NR Rel-17 UEs, PDCCH monitoring capability is defined per BWP and configuration of 480K/960K SCS for a BWP implies multi-slot-based capability for that BWP.  Proposal 4: PDCCH monitoring capability for a serving cell is the capability for its active BWP or configured first active BWP when it is deactivated. |

### R1-2111075 (ZTE, Sanechips)

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| In principle, the values of X should be configurable for more flexible operation in above 52.6 GHz band, that depend on UE capability. Firstly, X= 4 slots for 480 kHz and X= 8 slots for 960 kHz to align the absolute time of a slot with 120 kHz SCS with the existing PDCCH monitoring capability should be supported, also X=4 slots for 960kHz is optional according to the agreement made in RAN1#106bis e-meeting. In addition, smaller value of X can be investigated later after multi-slot PDCCH monitoring capability has been defined for X=4(for 480 kHz) and X=4/8(for 960 kHz). We need to de-prioritize smaller values of X for the sake of progress and conclude at least one workable solution to define the multi-slot PDCCH monitoring capability.  **Proposal 1: If multi-slot PDCCH monitoring based on slots within a slot group is supported, reporting the BD/CCE budget for X=4/8 slots (for 480/960 kHz resp.) is mandatory (if UE supports the corresponding SCS), and is optional for X=4 slots (for 960 kHz). De-prioritize other optional values of X (e.g. [2] slots for 480/960 kHz) .**  We can apply similar rules in multi-slot PDCCH monitoring as in Rel-15/16, Group (2) CSS sets are not restricted in Y slots, and they can locate in anywhere within a slot group. Group (1) SS sets should fit in the fixed multi-slot PDCCH monitoring pattern and the BD/CCE budget calculation should be joint for all the SSs. Furthermore, the capability indicates the BD/CCE budget within each slot group and at least Group (1) SS sets locate within Y consecutive slots. This option provides a complete solution for multi-slot PDCCH monitoring but it may cause back-to-back monitoring issue and increase UE power consumption.  Among those three solutions, we prefer Option 2 since this option not only aligns Group (1) SS with Group (2) CSS sets in the location of Y slots, but also avoids changing the default CSS configuration.  **Proposal 2: Align Group (1) SS with Group (2) CSS set in the location of Y slots.**   * **A SS is configured to be within Y consecutive slots within a slot group of X slots** * **The location of the Y consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)** * **The location of the Y consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) SS monitoring**   **Proposal 3:**   * **The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group** * **Support the following values of YGroup1 and YGroup2**   + **For X=8: (YGroup1,YGroup2) = (4,2), (3,2), (2,2), (1,2)**   + **For X=4: (YGroup1,YGroup2) = (2,2), (1, 2)**   **Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS**  **Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS** |

### R1-2111196 (Nokia, Nokia Shanghai Bell)

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| Based on the agreement made in RAN1 #106bis, fixed pattern of slot groups is used as the baseline to define the new capability for BD/CCE budget. We think that the next step would be to remove “FFS” from the agreement, i.e. confirm tha agreement as a whole.  ***Proposal 2*:** *Remove the FFS from the agreement made in RAN1 #106bis-e, i.e. confirm the agreement as a whole*  *Agreement:*   * *Multi-slot PDCCH monitoring is based on slots within a slot group*   + *[…]* * *There is a common BD budget for all search spaces* * *FFS: Search space configuration*   + *[…].*   The agreement made in RAN1 #106bis-e (behind FFS) states that “*the location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)*”. In order to support n0 changes, it makes sense to define the location of YGroup2 based on the (two) slots containing Type0\_PDCCH.   * Before the RRC connection establishment, the location YGroup2 follows the strongest beam, i.e. the SSB beam/index selected in the initial access procedure (and the associated Type0-PDCCH). * When the RRC connection has been established, the location of YGroup2 follows the TCI state adjustment for the CORESET (e.g. CORESET#0) to which CSS is/are associated.   ***Proposal 3*:** *YGroup2 within a slot group overlaps with the (two) slots containing Type0\_PDCCH*  In order to avoid back-to-back monitoring, it makes sense to determine the location of YGroup1 based on the location of YGroup2. To be more accurate, we propose that the location for YGroup1 is selected among the candidate locations fully overlapping with YGroup2.  ***Proposal 4*:** *Location of YGroup1 is selected among the candidate locations fully overlapping with YGroup2*  Figure 1 shows the possible locations for (YGroup1, YGroup2) for different values of X. It covers all the combinatins captured in the RAN1 #106bis-e agreement.   * Orange colour shows the size and the location of slot group having a duration of X slots * Blue colour shows the possible locations for YGroup2 available for Group (2) SSs   + Letters A, B, C, .. are used as identifiers for the locations * Yellow shows the possible locations for YGroup1 available for Group (1) SSs   + Green numbers (0, 1, 2, …) are used as identifies for thesese locations (=offset)   + Each possible location/offset includes the identifiers of the locations overlapping with YGroup2. These are the valid locations for YGroup1 with given locations for YGroup2.   UE and gNB should have common understanding on which candidate location for YGroup1 to select in different scenarios. Therefore, there is a need for defining the rules for which candidate location for YGroup1 to apply:   * When a UE starts monitoring Group (1) SS, it can determine the location for YGroup1 based on a configurable offset, given as part of the UE SS configuration (along with X). * The UE needs to re-evaluate the validity of location for YGroup1 when the location of YGroup2 changes, i.e. whether YGroup1 andYGroup2 overlap fully * When a new location for YGroup1 is needed, it can be selected e.g. according to the location with the smallest offset   ***Proposal 5*:** *UE needs to re-evaluate the validity of location for YGroup1 (i.e. overlap with YGroup2) when the location of YGroup2 changes:*   * *When a new location for YGroup1 is needed, it can be selected e.g. according to the smallest offset that results in full overlap between YGroup1 and YGroup2 .*     Figure 1. Candidate locations for Ygroup1 (yellow) and Ygroup2 (blue).  It can be noted that in back-to-back issue is completely solved for cases with X=8, X=4. In other words, all the monitoring occasions are always within X/2 slots of the slot group. This is not the case with (X, YGroup1,YGroup2) = (2, 1, 2). However, we think that this is not a problem:   * It has been agreed already that “Reporting the BD/CCE budget […] is optional for X=[2]/4 slots (for 480/960 kHz resp.) * We think that the added burden of monitoring outside of YGroup1 slots in this scenario is very small, and can be taken into account when deciding on the exact numbers of BDs and CCEs (see Section 4).   Based on the discussion above, we make the following proposal:  ***Proposal 6*:** *Support the following values of* YGroup1 *and* YGroup2   * + For X=8: (YGroup1,YGroup2) = (4,2), (2,2)   + For X=4: (YGroup1,YGroup2) = (2,2)   + For X=2: (YGroup1,YGroup2) = (1,2). |

### R1-2111242 (CATT)

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| The key issue is there is no benefit of separating the whole SS into two SS groups except adding extra complexity. What’s more, the problem caused is this could make the UE unnecessarily drop USS in the first group because of the ‘back-to-back’ issue of the multi-slot monitoring. In anyway, the corresponding Rel-15 design is problematic and we should not continue on the wrong route.  The following is the most promising version of proposal before RAN1 gets into the discussion of differentiating different search group and that is where we should start from.  ***Proposal 1: The FFS part of RAN1#106bis-e is closed and the following is agreed in addition to the previous agreement:***   * ***The reported capability indicates the BD/CCE budget within Y consecutive slots in each slot group***   + ***For reporting the BD/CCE budget, the UE may assume that the location of the Y consecutive slots within the X slots is maintained across different slot groups***   + ***UE reports its BD/CCE budget for Y=1 slot and Y=X/2 consecutive slots*** * ***A SS can be configured to be within Y consecutive slots within a slot group of X slots; the Y consecutive slots can be located anywhere within the slot group of X slots***   + ***The location of the Y consecutive slots within the slot group of X slots is maintained across different slot groups***   + ***BD attempts for all SS sets are restricted to fall within Y consecutive slots*** |

### R1-2111308 (OPPO)

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| The key discussion point of this contribution is on the FFS direction. During the last meeting, the main argument from the UE vendors is that the FR2-2 UE should be allowed to perform non-back-to-back monitoring, here the back-to-back mean two spans should be separated in time. However, on the other side, the network vendors believe that Group(2) SS should not be restricted by any span as it is the R15 situation that the Group(2) SS should be allowed to be placed anywhere. Obviously, these two design principles are mutually conflicting. Thus, in the last meeting, we have discussed about a compromised design, where the Group(1) SS and Group(2) SS should be aligned as much as possible. Thus, there is a proposal from last meeting that defining YGroup1 and YGroup2 for the Group(1) and Group(2) SS, respectively. The YGroup2 can be flexible within a slot group so that the network can maintain similar scheduling flexibility as in R15/R16 for Group(2) SS. At the same time, YGroup1 can be aligned with YGroup2, with this alignment, these two spans can be overlapped and both Group(1) SS and Group(2) SS can be restricted within a union of YGroup1 and YGroup2. Thus, it can already limit the back-to-back situations. Moreover, we YGroup2 is further reduce to 1 slot. The back-to-back situation can be completely avoided.    **Proposal 1: support the FFS point from the RAN1#106bis-e agreement**   * **Search space configuration**   + **For Group (1) SS**     - **A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots**     - **The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots**     - **The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**     - **BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots**   + **For Group (2) SS**     - **A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots**     - **The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**   + **The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group**   + **Support the following values of YGroup1 and YGroup2**     - **For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1,[1 or 2])**     - **For X=4: (YGroup1,YGroup2) = (2,2), (1,[1 or 2])**     - **For X=2: (YGroup1,YGroup2) = (1,[1 or 2])**   + **Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS** |

### R1-2111419 (Charter)

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| **Proposal 1a: Support the FFS portion for SS configuration in the RAN1#106-e agreement on multi-slot PDCCH monitoring with following values of** YGroup1 **and** YGroup2   * + **Support the following values of YGroup1 and YGroup2**     - **For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1, 2)**     - **For X=4: (YGroup1,YGroup2) = (2,2), (1,2)**     - **For X=2: (YGroup1,YGroup2) = (1,1)**   **Proposal 1b: Support SS dropping in case n0 changes.**  For general PDCCH monitoring with 480/960 kHz SCS, a simple extension of Rel-15/16 dropping rules is sufficient for BD budget compliance.  **Proposal 2: All PDCCH candidates for UE-SS k with k>=j across the Y slots will be dropped if the number of monitored PDCCH candidates and non-overlapped CCE exceeds the maximum numbers per X-slot after SS j is added (assuming that the BD/CCE budget is checked in order of increasing SS index (as in in Rel-15)) but doesn’t exceed the budget before SS j is added.** |

### R1-2111464 (Ericsson)

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| 1. Per Rel-15/16 specs (see 38.213 Section 10.1), the UE monitors PDCCH candidates for search space set in a slot with number in a frame with number if where , , and are the configured periodicity, offset and duration, respectively, of the search space .   In Rel-15 for slot-based PDCCH monitoring, the following UE capabilities [4] are defined with respect to which OFDM symbols within a slot shall be monitored which is related to the configuration parameter *monitoringSymbolsWithinSlot*:   * Mandatory UE capability (FG 3-1)   + Group (1) SSs monitored in first 3 OFDM symbols of a slot   + Group (2) SS monitored in any single span of 3-consecutive symbols in a slot * Optional UE capability (FG 3-5), also known as Case 2 monitoring   + Group (1) SSs monitored in any OFDM symbols of a slot   where   * Group (1) consists of Type 1 CSS with dedicated RRC configuration, Type 3 CSS, UE specific SS * Group (2) consists of Type 1 CSS without dedicated RRC configuration and Type0, 0A, and 2 CSS   A proposal was put forth during the RAN1 #106b email discussion that the monitoring slot offset of the Group (1) search spaces within the X-slot groups should be tied to the slot offset within the X-slot groups of the Group (2) search space. We show an example of defining fixed X-slot group boundaries in Figure 1. In this example, the first monitoring slot for type0 PDCCH is slot . With X=4, a monitoring slot offset within slot group can be computed as 22 mod 4 = 2. This monitoring slot offset within the slot group is then to be applied to Group (1) search spaces such that the monitoring slots of both Group (1) and Group (2) search spaces can be aligned.    Figure 1: Examples of defining fixed X-slot group boundaries. A slot offset within X-slot group based on the first monitoring slot for the type0 PDCCH is applied to the monitoring occasions of Group (1) search spaces. This example is for X=4 and Ygroup1=1.  The proposal is consistent with the view that X-slot groups are first defined, and then the monitoring occasions of a search space may be located with offset(s) from the start of the X-slot groups that should also be fixed across different X-slot groups (until changes). There are hence several offsets and monitoring boundaries at play. And that appeared to cause obstacle to a common language and understanding amongst the participating discussion partners.   1. For operation with 480/960 kHz SCS multi-slot PDCCH monitoring, common language and understanding is hindered by the required definitions of several offsets and monitoring boundaries, if the discussion starts with fixed X-slot group boundaries.   We understand a lot of discussion went into the following agreement during the last meeting:   * + - The start of the first slot group in a subframe is aligned with the subframe boundary   However, based on the discussion during the last meeting, we also observed much misalignment of understanding and views of the above-described search space offsets. The misalignment may lead to further roadblocks in finalizing the details of the multi-slot PDCCH monitoring for 480/960 kHz SCS.  In the following, we would like to explore whether a simpler and possibly more robust approach can be considered by RAN1. This alternative approach is to consider that   * **The X-slot group grid/boundaries align with the first monitoring slot for the type0 PDCCH (and remain fixed until changes); and** * **The monitoring occasions for Group (1) SSs are always placed at the beginning of a slot group.**   Based on the above analysis, we propose to modify the definition of X-slot group grid as follows:   1. For operation with 480/960 kHz SCS multi-slot PDCCH monitoring with slot group size of X, the UE determines that a slot with index in a frame with index is the start of a X-slot group if   where is the slot group grid offset. With this X-slot group grid definition, the monitoring slot(s) for all search spaces are always at the beginning of a slot group and back-to-back PDCCH processing overloading is avoided.   1. For a 480/960 kHz SCS serving cell operating with multi-slot PDCCH monitoring with slot group size of X, the slot group grid offset is determined as   where is the index of the first monitoring slot for the type0 PDCCH on the PCell/PSCell if the PCell/PSCell operates with multi-slot PDCCH monitoring and if the PCell/PSCell does not operate with multi-slot PDCCH monitoring.   1. For operation with 480/960 kHz SCS multi-slot PDCCH monitoring with slot group size of X, the UE determines that a PDCCH monitoring occasion for search space in Group (1) is in slot with index in a frame with index if   where , , and are the configured periodicity, offset and duration of the search space in terms of X-slot groups, and is the slot group grid offset.  In addition to the support of X=4 for 480 kHz SCS and X=8 for 960 kHz SCS, several companies proposed the support of per-slot PDCCH monitoring as well as multi-slot PDCCH monitoring other than these two cases as optional UE capabilities. In our view, this distracts and slows down RAN1 from finalizing the core multi-slot PDCCH monitoring designs. Therefore, we propose   1. For operation with 480/960 kHz SCS, multi-slot PDCCH monitoring other than X=4 for 480 kHz SCS and X=8 for 960 kHz SCS is deferred until RAN1 completes the details of multi-slot PDCCH monitoring with X=4 for 480 kHz SCS and X=8 for 960 kHz SCS including at least (1) Details of multi-slot PDCCH monitoring? (2) The minimum supported values of Y for the respective X values? (3) What symbols within the Y slots for PDCCH monitoring? (4) The BD/CCE budget requirement for the X-slot window? 2. For operation with 480/960 kHz SCS, if the optional per-slot PDCCH monitoring is discussed, the discussion in RAN1 should start with defining the BD/CCE budget for a slot while ensuring that Rel-15 Type0-PDCCH monitoring requirements can be met.   For Rel-17 operation in the FR2-2 range, maintaining the same initial access procedures and IDLE mode operations is beneficial to reducing implementation complexity and shortening time to market. Hence, the same NR system design principle that the Rel-15 UEs are required to support more flexible monitoring occasions in initial access and in the IDLE mode should be followed for a more streamlined Rel-17 specs. With Option B-FL1 as a direct extension of Rel-15 mandatory UE capability to the multi-slot monitoring case, the BD/CCE budget for an X-slot window is first allocated for monitoring CSS located within the X-slots, with the remaining budget utilized for monitoring USS according to ascending USS index. The presence of type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS within an X-slot window, regardless of where such a CSS locates within the X-slot window, has no impact on the BD/CCE budget for the next X-slot window. This is still a solution preferred by several companies for Rel-17 multi-slot PDCCH monitoring if RAN1 does not converge on the compromised solution discussed in Section 2.1.   1. Multi-slot PDCCH monitoring definition Option B-FL1 from the feature lead summary is adopted for Rel-17 multi-slot PDCCH monitoring with 480/960 kHz SCS if RAN1 does not converge on the compromised solution discussed in Section 2.1. |

### R1-2111484 (Intel)

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| According to the agreements in last meeting, the multi-slot PDCCH monitoring capability is defined based on Alt 1, i.e., a fixed pattern of slot groups. Each group has X consecutive slots. the slot groups are consecutive and non-overlap. Further, though there is no explicit agreement, it is common understanding that at USS set will be limited to Y consecutive slots in each X-slot group. The location of the Y consecutive slots within a slot group of X slots is maintained across different slot groups. Regarding other SS sets, different considerations are necessary for different SS sets. The potential candidate solutions being discussed include   * All SS sets in the same Y consecutive slots (Option A or A-rev1 in early discussion) * Group (2) SS can be anywhere in a X-slot group (Option B in early discussion) * Group (2) SS in Y=2 slots as that for search space set 0 (Option B-rev1 in early discussion) * Ygroup1 slots for Group (1) SS, Ygroup2 slots for Group (2) SS, where the Ygroup1 slots overlap with the Ygroup2 slots (Option A-FL1 in early discussion or the FFS in agreements)   The SS set 0 is associated with a SSB. The SS set 0 may be configured to carry Type0/0A/1/2 CSS sets. In existing NR, the relative timing between a SSB and the slot carrying SS set 0 is defined in section 13 in TS 38.213. The SS set 0 for a SSB can be transmitted in two consecutive slots which is referred as slot n0, n0+1. gNB has the flexibility that either one of slots n0, n0+1 can be used to carry the SS set 0 for the SSB. For FR2-2 with SCS 480kHz and 960kHz, one proposal is to only map SS set 0 in single slot n0. It is not preferred since it reduce the flexibility for gNB scheduling. on the other hand, another proposal is to map SS set 0 in two slots n0, n0+X. It has the benefit that there is at most one slot for SS set 0 in a X-slot group. However, if slot n0 is used for some SSBs and slot n0+X is used for other SSBs, the transmission of RMSI PDCCH/PDSCH may not be in the same order as the transmission of the multiple SSBs, which complicates gNB scheduling.  **Proposal 1:**   * The CORESET 0 associated with a SSB is mapped in two consecutive slots as in existing NR.   For Type0A/2 CSS sets, if it is configured with *searchSpaceID* 0, the PDCCH monitoring occasion are same as that for SIB1, i.e., SS set 0. On the other hand, if Type0A/2 CSS sets are configured with *searchSpaceID* non-zero, the MOs of Type0A/2 CSS sets are sequentially numbered and mapped to the actual transmitted SSBs according to *ssb-PositionsInBurst* in *SIB1*, where the actual transmitted SSBs are sequentially numbered in ascending order of their SSB indexes. That is, the [x×N+K]th PDCCH MO(s) of Type0A/2 CSS sets corresponds to the Kth transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N. In the latter scheme, it is possible that the slot offset of the [x×N+K]th PDCCH MO(s) of Type0A/2 CSS sets in a X-slot group is different from the slot offset of Type0 CSS set of the Kth transmitted SSB in the X-slot group. Option B of the candidate solutions is directly applicable, since there is no limitation on the slot of Type0A/2 CSS sets in a X-slot group. For all other candidate solutions, special handling is needed for Type0A/2 CSS sets with *searchSpaceID* non-zero.  **Observation 1:**   * For Type0A/2 CSS sets configured with *searchSpaceID* non-zero, the determined PDCCH MO for a transmitted SSB may not be in the same slot offset as the SS set 0 in a X-slot group * For all candidate solutions other than Option B, special handling is needed for Type0A/2 CSS sets with searchSpaceID non-zero.   **Proposal 2:** For Type0A/2 CSS sets configured with searchSpaceID non-zero   * It can be handled by Option B, i.e., Group (2) SS can be anywhere in a X-slot group. * If other options except Option B is used, FFS how to align the slot offset of the MOs of Type0A/2 CSS sets and the slot offset of Type0 CSS set for the same SSB.   For Type1 CSS sets without dedicated RRC configuration, any candidate solutions can be considered since there is no issue of 1-by-1 mapping between the MOs of Type1 CSS sets and transmitted SSBs. Being a cell specific SS set, any candidate solution of Option A or A-rev1 is applicable. On the other hand, Option A or A-rev1 is also applicable if the Y slots always include the slots configured Type1 CSS sets without dedicated RRC configuration. However, it is essentially different handling between Type1 CSS sets without dedicated RRC configuration and a SS set with dedicated RRC configuration. For Type1 CSS sets with dedicated RRC configuration and Type3 CSS, it can be easily configured in the Y consecutive slots for USS sets since anyway dedicated RRC signaling is used for the SS set configuration.  **Observation 2:**   * For Type1 CSS sets without dedicated RRC configuration, any candidate solutions can be considered. * For Type1 CSS sets with dedicated RRC configuration and Type3 CSS, it can be easily configured in the Y consecutive slots for USS sets since anyway dedicated RRC signaling is used for the SS set configuration.   **Proposal 3:** Type1 CSS sets without dedicated RRC configuration is handled differently from other CSS/USS sets with dedicated RRC configuration.  Based on the above analysis, Option B is the solution that is universally applicable for all kinds of CSS/USS sets. If Option B is agreeable, it seems avoiding all/most remaining issues which have to be addressed if other option is adopted. Option A or A-rev1 is not preferred since it enforces to configure cell specific SS sets in the UE specific Y consecutive slots. Option B-rev1, A-FL1 or the FFS in the agreements can be considered but special handling for Type0A/2 CSS sets configured with searchSpaceID non-zero is necessary.  **Proposal 4:** For multi-slot PDCCH monitoring capability   * It is preferred to adopt Option B, i.e. Group (2) SS can be anywhere in a X-slot group. * If Option B is not agreeable, Option B-rev1, A-FL1 or the FFS in the agreements can be further discussed. Special handling for Type0A/2 CSS sets configured with searchSpaceID non-zero is necessary   In the agreement in last meeting, the value 2 for X is in bracket. We prefer to support X=2 for both SCS 480kHz and 960kHz. In fact, X=2 enables a good balance between number of BD/CCE per slot group and frequent PDCCH monitoring which is especially useful in fast channel access based on LBT. One further issue is whether per-slot PDCCH monitoring capability, i.e., X=1 can be supported for SCS 480/960kHz. It is expected that the number of BDs/CCEs per slot that can be monitored by a UE is reduced a lot for the high SCSs. On the other hand, if it is still applicable to support a PDCCH candidate with aggregation level, e.g., 16 or 8, per-slot PDCCH monitoring capability may be considered for FR2-2 too.  **Proposal 5:**   * X=2 can be optionally supported for both SCS 480kHz and 960kHz * X=1, i.e. per-slot PDCCH monitoring capability may be supported subjected to a further discussion on the maximum number of BD/CCE in a slot.   In Option B-rev1, A-FL1 or the FFS in the agreements, the common part is to configure Group (1) SS is Ygroup1 consecutive slots and configure Group (2) SS is Ygroup2 consecutive slots. In our views, the following combinations of X, Ygroup1 and Ygroup2 can be supported. An active combination for UE operation can be derived explicitly or implicitly.   * For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1,2) * For X=4: (YGroup1,YGroup2) = (2,2), (1,2) * For X=2: (YGroup1,YGroup2) = (1,2)   **Proposal 6:** If Option B-rev1, A-FL1 or the FFS in the agreements is considered, the following combinations of (X, Ygroup1, Ygroup2) can be supported   * For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1,2) * For X=4: (YGroup1,YGroup2) = (2,2), (1,2) * For X=2: (YGroup1,YGroup2) = (1,2) |

### R1-2111563 (Xiaomi)

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| From our view the first thing that needs to considered is, whether multi-slot PDCCH monitoring capability is a mandatory capability that should be applied for RRC idle mode, or it is just a capability applied for RRC connected mode.  A similar PDCCH symbol-level PDCCH monitoring span has been discussed and introduced in R16 URLLC. And in that WI, R15 slot level PDCCH monitoring capability is a mandatory capability that should be applied in RRC idle mode, and if UE is configured with *r16monitoringcapability*, UE will apply symbol-level span PDCCH monitoring capability, which is only possible in RRC connected mode. And in this case, how to guarantee CSS, especially CSS before RRC connection, and USS fall into the PDCCH monitoring span is up to gNB implementation.  If we determine that multi-slot PDCCH monitoring capability is a capability that only can be used after corresponding UE capability reporting and gNB configuration, that is multi-slot PDCCH monitoring capability is only for RRC connected, then for RRC idle mode, UE should apply single-slot PDCCH monitoring similar as in R15, which we slightly prefer, since it is easy to guarantee CSS reception by single-slot PDCCH monitoring.  ***Proposal 1: RAN1 needs to decide whether multi-slot PDCCH monitoring capability is mandatory applied in RRC idle mode. If not, single-slot PDCCH monitoring capability, which is quite easy to handle CSS receiving, should be defined for NR 52.6-71GHz.***  If we determine that multi-slot PDCCH monitoring capability is mandatory for RRC idle, then a suitable mandatory multi-slot PDCCH monitoring pattern should be designed to guarantee Type #0/0-A/1/2 CSS reception in the first place. Take Type #0 CSS as an example, SSB/corset 0 multiplexing pattern 1, index=4 of the Table 13-11 TS 38.213, total SSB number is 8, 15KHz SCS for CORESET 0 with 2 symbol length. The time domain location of Type #0 CSS corresponding to each SSB are,  SSB 0: symbol 0/1 on slot 5, 6 of even SFN  SSB 1: symbol 0/1 on slot 6, 7 of even SFN  SSB 2: symbol 0/1 on slot 7, 8 of even SFN  SSB 3: symbol 0/1 on slot 8, 9 of even SFN  SSB 4: symbol 0/1 on slot 9 of even SFN and symbol 0/1 on slot 0 of odd SFN  SSB 5: symbol 0/1 on slot 0, 1 of odd SFN  SSB 6: symbol 0/1 on slot 1, 2 of odd SFN  SSB 7: symbol 0/1 on slot 2, 3 of odd SFN  It can be seen that on different SSB beams, Type #0 CSS is scattered on almost every slot within a frame. To make sure an idle UE can monitor Type #0 CSS on any SSB beam, the location of Y slots should be floating. So in Alt 1 with a floating Y, or Alt 2 can be adopted for receiving CSS in idle mode.  ***Observation 1: If to apply multi-slot PDCCH monitoring capability in RRC idle mode, the location of Y slots should be floating within X slot-group.*** ***That is within different X slots, the Y slots can have different locations.***  In RRC connected mode, Group (1) SS will be configured in addition to the already existed Group (2) SS. To make sure that UE can monitor USS/CSS in the same Y slots within X slot-group, Group (1) SS and Group (2) SS should have harmonized periodicity, that is the periodicity of Group (1) SS is integer factor or multiple of the periodicity of Group (2) SS. That means, the configuration of Group (1) SS should be harmonized with the Group (2) SS, as shown in Fig 1. And it would post some restriction on the configuration flexibility of Group (1) SS.  ***Observation 2: To make sure all USS/CSS can fall into Y slots, the periodicity of Group (1) SS should be integer factor or multiple of the periodicity of Group (2) SS.***    Fig 1. Group (1) SS and Group (2) SS with harmonized periodicity  But only harmonized SS configuration is not enough, it also depends on the value of (X/Y) to decide whether Group (1) SS and Group (2) SS can fall into the Y slots. To guarantee CSS/USS monitoring as shown in Fig 2, X should be equal to the minimum SS periodicity, that is X=5. And a fixed pattern (5/3) will be feasible. But if X is not equal to the minimum SS periodicity, for example, X=4, then a floating Y will be needed to make sure Group (1) SS and Group (2) SS can fall into the same Y slots within a X slot group.  ***Observation 3: With harmonized Group (1) SS and Group (2) SS periodicity, X should be equal to the minimum SS periodicity, otherwise, a floating Y is needed.***  Based on the above analysis, we can make the summary  ***Summary 1: To make sure Group (1) SS and Group (2) SS fall into the same Y slots within a X slot group, gNB has to guarantee,***   * ***The periodicity of Group (1) SS should be integer factor or multiple of the periodicity of Group (2) SS, and*** * ***X should be equal to the minimum SS periodicity of Group (1) SS and Group (2) SS, otherwise, a floating Y is needed***   From the above analysis, we can see that, there are strict restrictions on the SS periodicity configurations to make sure Group (1) SS and Group (2) SS fall into the same Y slots. And a floating Y is needed if X is not equal to the minimum SS periodicity.  However, if it is allowed that Group (2) SS can be located in anywhere within a X slot group, the restrictions on the SS periodicity configurations can be released. For example, Group (2) SS can have its own periodicity configuration, which is not limited by X/Y, or by Group (1) SS at all. But still X should be equal to the minimum SS periodicity of Group (1). One concern raised by companies about allowing Group (2) SS in anywhere within a X slot group, is that the two monitoring occasions from different X slot groups are too close to each other, as shown in Fig.2, and UE may not be able to process PDCCH in so many consecutive slots. And it should be noted that, the same issue also exists when Group (1) SS and Group (2) SS fall into the same Y slots, but X is not equal to the minimum SS periodicity of Group (1) SS and Group (2) SS. Simple solutions may be dropping one of the monitoring occasion, for example, the USS.    Fig 2. Two monitoring occasions from different X slot groups are too close to each other  ***Proposal 2: If Group (2) SS can be located in anywhere within a X slot group, or floating Y is adopted, some of the monitoring occasions can be dropped to solve the issue two monitoring occasions from different X slot groups are too close to each other.***  At this stage, we have very limited time to solve the issues caused by floating Y or random location of Group (2) SS. so our preference is as Proposal 3,  ***Proposal 3: Suggest RAN1 to adopt***   1. ***Apply single slot PDCCH monitoring capability for RRC idle mode*** 2. ***Group (1) SS and Group (2) SS should fall into the same Y slots within a X slot group, and the location of Y slots is maintained across different X slot groups.***   Compared with defining PDCCH monitoring capability per single slot, defining PDCCH monitoring capability per multi-slot span would allow gNB scheduling DCI in a busty way, for example when X=8,Y=1. And it may cause the UE to spend more time on decoding all the DCIs scheduled in a DCIs burst, which will increase the total processing time for the scheduled PDSCH/PUSCH since UE has to decoding the DCI first. For example, with maximum number of B1/C1 of BDs/CCEs for PDCCH monitoring per single slot, UE is able to decode the all the DCIs in PDCCH in 1 symbol from the end of the PDCCH. But with maximum number of 4\*B1/4\*C1 of BDs/CCEs for PDCCH monitoring per multi-slot span (4/1) and gNB scheduling DCI in a busty way, UE may need extra 2 symbols to guarantee to decode the all the DCIs in PDCCH, thus cause the decoding time of PDSCH(N1) and preparation time of PUSCH(N2) may need to be extended as well.  ***Proposal 4: Impacts on PDSCH/PUSCH processing time (N1/N2) may need be considered for multi-slot PDCCH monitoring capability.*** |

### R1-2111642 (Lenovo, Motorola Mobility)

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| ***Proposal 1: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, following search space configuration should be supported:***   * + ***For Group (1) SS***     - ***A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots***     - ***The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots***     - ***The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)***     - ***BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots***   + ***For Group (2) SS***     - ***A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots***     - ***The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)***   + ***The reported capability indicates the BD/CCE budget within Y=max(YGroup1, YGroup2) slots per slot group***   + ***Support the following values of YGroup1 and YGroup2***     - ***For X=8: (YGroup1,YGroup2) = [(4,4) or (4,2)], (2,2), (1,1)***     - ***For X=4: (YGroup1,YGroup2) = (2,2), (1,1)***     - ***For X=2: (YGroup1,YGroup2) = (1,1)***     - ***In case of other supported values, YGroup1 should always be less than or equal to X/2***   + ***Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS***   + ***Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS***   However, there could still be the issue of back-to-back monitoring across slot groups e.g. when the beam changes, e.g. with respect to the above proposal when n0 changes. An example is shown in Figure 1. In this example, the original location of the SS is last 2 slots within a slot group, as shown in slot group 1. Now in slot group 2, the CSS MOs are in the 1st two slots of the slot group. So as a consequence of the transition there can be the issue of back-to-back monitoring. Similar issue of back-to-back monitoring could arise even for Group(2) SS when the periodicity of Group(2) SS MO is every slot group.    **Figure 1: Example of back-to-back monitoring when n0 changes**  ***Observation 1: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, when multi-slot PDCCH monitoring is applied with shifting of Group(1) SS due to n0 change, then potential back-to-back monitoring issue can arise across slot groups where the shift is applied***  ***Observation 2: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, when multi-slot PDCCH monitoring is applied with shifting of Group(2) SS due to n0 change, then potential back-to-back monitoring issue can arise across slot groups where the shift is applied, and periodicity of Group(s) SS MOs is every slot group***  One potential solution could be to drop any Group(1) SS MOs and/or Group(2) SS MOs in the slot group in which shifting needs to be applied such that back-to-back monitoring issue can be avoided. Therefore, in above example, there will be no Group(1) SS MO in slot group 2. The shifted MO for Group(1) SS can be applied from slot group 3, as shown in Figure 2 below.  ***Proposal 2: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, then dropping of Group(1) SS MOs and/or Group(2) SS MOs in the slot where the shift is first applied should be supported*** |

### R1-2111673 (Transsion Holdings)

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| Based on the above conclusions, the multi-slot PDCCH monitoring capability of Group (2) SS (such as CORESET#0/Type0-PDCCH CSS) needs to be solved. For SS/PBCH block and CORESET#0 multiplexing pattern 1, the PDCCH monitoring occasions are located within two consecutive slots which are associated with the SS/PBCH block. However, when the UE changes SS/PBCH block it tracks due to mobility, the relevant PDCCH monitoring occasions may be outside the YGroup1 consecutive slots, which will affect the monitoring capability of the UE. In order to keep the PDCCH monitoring occasions of Group (1) SS overlapping or adjacent to the PDCCH monitoring occasions of Group (2) SS, the same time offset to the slot group boundary should be used for the PDCCH monitoring occasions of Group (1) SS, when UE changes the monitoring occasions of Group (2) SS based on the slot index of n0. In the current specification, the monitoring occasion of Group (2) SS is switched by the MAC CE activation command to indicate a new TCI state. Therefore, a new procedure should be specified to allow the monitoring occasion of Group (1) SS to shift in the time domain based on reception of the MAC CE activation command within an slot group. One way to achieve this is to configure a separate time offset for Group (1) SS associated with corresponding TCI state.  ***Proposal 2: The monitoring occasions of Group (1) SS should overlap or be adjacent to the monitoring occasions of Group (2) SS within a slot group.***  ***Proposal 3: The monitoring occasions of Group (1) SS should be switched, when the monitoring occasions of Group (2) SS is changed based on the n0 slot index.***  In RAN1#106bis-e meeting, it was the proposed that the value of Y is determined by the equation Y=max(YGroup1, 2) slots. It can be seen from the equation that the minimum value of Y is 2. Therefore, two slots can be regarded as a minimum unit of BD/CCE budget. However, if the value of 1 is adopted for YGroup2, given that the PDCCH monitoring occasion of Group 1 overlaps with the PDCCH monitoring occasion of Group 2, then only one slot is used to locate the PDCCH within a slot group. In such case, the minimum of Y is meaningless, because only one slot is used for PDCCH monitoring occasion. On the other hand, in order to maintain the same design principles as Rel-15 CORESET#0/Type0-PDCCH CSS monitoring occasion, the value of 2 is suitable for Group 2 SS monitoring occasion.  ***Proposal 4: The value of YGroup2 should be 2.*** |

### R1-2111691 (NEC)

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| For 480 kHz and 960 kHz SCS adopted beyond 52.6GHz, In the WID [3], PDCCH monitoring enhancement with multi-slot span is supported, it can maintain scheduling framework same as for smaller SCS (e.g. 120 kHz) when UE is configured to monitor the PDCCH every multiple slots.  In previous meeting [1], there were many discussions on multi-slot PDCCH monitoring capability, and it has been agreed Multi-slot PDCCH monitoring is based on slots within a slot group, and search space configuration is for further study. There are 3 options listed by FL in the fourth round discussion summary [4]. In our view, if Option B-rev1 is adopted, in order to avoid the back-to-back overload issue, there are 2 options: 1. an extra window can be considered to calculate the PDCCH monitoring burden. In this extra window with size equivalent to X, the monitoring capability indicates the BD/CCE budget within the whole window. 2. Skip monitoring Group (1) SS in the next slot group.    Figure 1  **Proposal 1: For Option B-rev1 listed in the fourth round discussion, to avoid the back-to-back overload issue, an extra window can be considered to calculate the PDCCH monitoring burden if Group (2) SS don’t fall into Y monitoring slots.**  In meeting 106-bis-e, it was agreed that the following values are mandatorily supported: 4 slots for 480 kHz SCS and 8 slots for 960 kHz SCS, and other specific number of the multiple slots is in discussion. For some use cases such as low-latency services which require more frequent PDCCH monitoring, the flexibility will be reduced with the multi-slot based monitoring. To handle those use cases with low-latency, denser PDCCH monitoring occasion should be considered to support, such as per 2-slots based monitoring for 480 kHz SCS and per 4-slots based monitoring for 960 kHz SCS, and accordingly the associated BD/CCEs limit number needs to further study.  Proposal 2: Additional PDCCH monitoring group sizes should be supported: 2 for 480 kHz SCS, 4 for 960 kHz SCS, and further study the associated BD/CCEs limit number. |

### R1-2111708 (Panasonic)

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| According to the agreement in previous meeting (see Section 1), Alt-1 (i.e. use a fixed pattern of slot groups) has been selected to define the multi-slot monitoring capability eventually. One of the remaining controversial points is whether and how to restrict the search space configuration such that UE only needs to monitor Y slots in each slot group of X slots. The description under the third bullet in the agreement (i.e. FFS: search space configuration) is an attempt to provide a solution. In the following, we provide our analysis on this aspect.  In order to make MOs from both Group (1) and Group (2) SS fall into Y slots, the location of Y would need to be determined by Group (2) SS, because its configuration cannot be adapted by dedicated RRC. Once the location of Y is determined, a time shift is applied to Group(1) SS such that they would fall into Y. In order to clearly describe such behavior, the notion of YGroup1 and YGroup2 are used. We support the current formulation in the first and second sub-bullet. In the following, we illustrate how this can work using one example in Figure 1.    Fig.1 Determination of the location of YGroup1 and YGroup2  As shown in Fig.1, the UE was previously served (e.g. in the slot group n-1) by the yellow beam, and therefore both YGroup1 and YGroup2 start at the first slot of a slot group (note that YGroup2 does not show in the slot group n-1 because no Group (2) MO in this slot group). Let us then consider the case where the UE serving beam is changed from the yellow to green beam in the slot group n, due to, e.g. UE movement. In such case, YGroup2 would change to the last two slots of the slot group to cover the MOs of the corresponding beam. Consequently, a time shift would be applied to MO of Group (1) SS (and YGroup1 as well), such that MO would still fall into the new position of YGroup2. In other words, YGroup1 follows the same change in the location as YGroup2 in order to remain overlapping. In our opinion, such mechanism provides an efficient way to cope with issue of alignment between Group(1) and Group(2) SS in case of beam switching.  Regarding the third sub-bullet (i.e. “The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group”), from our understanding, it implies that BD/CCE budget is allowed to use over two slots (for Group(2)) even if UE supports YGroup1 = 1 only. We understand the intention is to keep the type-0 CSS monitoring behavior as it is in Rel-15/16. Therefore, we support this sub-bullet.  On the other hand, it is not clear to us the intention of the fourth sub-bullet (i.e. supported combination of YGroup1 and YGroup2 for X=8, 4, and 2). Does it mean that UE reports both values of YGroup1 and YGroup2 ? Since YGroup2 is used for cell-common information, it doesn’t seemingly make sense for individual UE to report different YGroup2 values, because for the broadcast information, network has to consider the worst-capable UE. Therefore, we suggest to define YGroup2 =2 slots for all UEs, which is also more consistent with the third sub-bullet.  To summarize, we propose to agree with the following in this meeting:  **Proposal 1: For the search space configuration, agree the FFS in the previous meeting with the following modifications:**   * + **For Group (1) SS**     - **A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots**     - **The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots**     - **The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**     - **BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots**   + **For Group (2) SS**     - **A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots**     - **The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**   + **The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group**   + **Support the following values of YGroup1 and YGroup2**     - **YGroup2 =2 for all UEs**     - **For X=8: ~~(Y~~~~Group1~~~~,Y~~~~Group2~~~~) = (4,2), (2,2), (1,[1 or 2])~~ Y Group1 = 4,2,1**     - **For X=4: ~~(Y~~~~Group1~~~~,Y~~~~Group2~~~~) = (2,2), (1,[1 or 2])~~  Y Group1 = 2,1**     - **For X=2: ~~(Y~~~~Group1~~~~,Y~~~~Group2~~~~) = (1,[1 or 2])~~ Y Group1 = 1**   + **Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS**   + **Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS** |

### R1-2111726 (Samsung)

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| In the last meeting, potential issue regarding the alignment between Group (1) SS and Group (2) SS due to UE movement was discussed, but the motivation is still not clear. In connected mode, if a UE moves and decides to switch the SS/PBCH block and the associated Group (2) SS, a beam failure recovery procedure will be triggered first, before the RRC reconfiguration of the Group (1) SS. The beam failure recovery procedure is typically a long delay procedure including beam failure detection, new beam selection, beam failure request transmission (e.g. for Rel-15, contention free RACH; for Rel-16: transmit PUCCH-SR + receive uplink grant + transmit PUSCH-MAC CE), receive beam failure recovery response, and new beam reset, wherein the overall delay of BFR can be hundreds of ms. Reconfiguration of RRC, as the follow-up step, may only take tens of ms, so avoiding the reconfiguration of RRC for the Group (1) SS may not be efficient for remarkably reducing the overall latency for switching the beam for Group (2) SS. In this sense, we didn’t a strong motivation to introduce a time offset to align the location of Group (1) SS and Group (2) SS.  Based on above discussion, we have the following proposal for multi-slot PDCCH monitoring:  **Proposal 1: Support Option A for multi-slot PDCCH monitoring:**   * **Y=1 is mandatory, and Y=X/2 is optional;** * **UE only monitors one slot for Type0-PDCCH:**   + **Alt 1: the one slot is slot for all cases;**   + **Alt 2: the one slot is slot for and , and configurable between slot and for** * **No need to introduce the time offset for aligning Group (1) and Group (2) SS.**   No matter which option for UE capability of multi-slot PDCCH monitoring is adopted, the default UE capability can be utilized for IDLE mode, wherein only Group (2) SS is applicable, and it can save the discussion effort on supporting slot based PDCCH monitoring.  **Proposal 2: For IDLE mode:**   * **Support the mandatory UE capability for multi-slot PDCCH monitoring;** * **Don’t support slot based PDCCH monitoring.** |

### R1-2111833 (InterDigital)

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| Given the limited time, approval of the FFS point is preferred, however, larger values should be supported for YGroup2 to ensure flexibility of Type 1 CSS without dedicated RRC configuration and type 0, 0A and 2 CSS.  ***Proposal 1:*** *Approve the FFS point with the following values of YGroup1 and YGroup2:*   * *For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1, 2)* * *For X=4: (YGroup1,YGroup2) = (2,2), (1, 2)* * *For X=2: (YGroup1,YGroup2) = (1, 2).* |

### R1-2111862 (Apple)

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| In summary, we support a MSM framework with Group 1 SS in YGroup1 slots, and Group 2 SS in YGroup2 slots where YGroup1 and YGroup2 overlap and YGroup1 = YGroup2 = 1. YGroup1 =X/2 may be optional.  A mechanism should be specified to ensure that the location of YGroup1 and YGroup2 is based on an offset and the offset of YGroup1 changes if there is a change in the offset of YGroup2.  Procedures on overbooking and dropping may be discussed once the MSM methodology is finalized.  ***Proposal 1:*** *To support multi-slot PDCCH monitoring, YGroup1 and YGroup2 overlap and YGroup1 = YGroup2 = 1. YGroup1 =X/2 is optional.*   * *Support the following values of YGroup1 and YGroup2* * *For X=8: (YGroup1,YGroup2) = ( (1, 1)* * *For X=4: (YGroup1,YGroup2) = (1,1)* * *For X=2: (YGroup1,YGroup2) = (1,1)*   ***Proposal 2:*** *A mechanism should be specified to ensure that the location of YGroup1 and YGroup2 is based on an offset and the offset of YGroup1 changes if there is a change in the offset of YGroup2.*   * *This mechanism can be based on (a) RRC reconfiguration (b) MAC-CE Activation or (C) DCI signaling (in the case a joint TCI state as specified in Rel-17 is used).*   ***Proposal 3:*** *On the values of X for Alt-1 and Alt-2:*   * *Single-slot PDCCH monitoring for 480 kHz and 960 kHz is not supported.* * *The configurable values for multi-slot PDCCH monitoring operation should be same as the reported X value(s).* * *The UE is not expected to handle a scenario in which they are different, and a UE might report its monitoring capability for more than one (X,Y) combination.* * *For each SCS 480 kHz and 960 kHz, the minimum configurable multi-slot PDCCH monitoring periodicity is the smallest value X that a UE supports when reporting its PDCCH monitoring capabilities for the corresponding SCS and are UE specific.*   ***Proposal 4:*** *there is no need to increase the CORESET duration i.e., the maximum CORESET duration ≤ 3.* |

### R1-2112012 (Sharp)

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| Since multi-slot monitoring is considered to be an extension of single-slot monitoring, Alt.1, which is aligned with a slot boundary, can simplify the enhancement of SearchSpace and reduce the standardization effort. On the other hand, several companies have pointed out that Alt.2 is more flexible than Alt.1 because the span interval can be freely determined. However, Alt.1 also allows flexible MO distribution by considering search space configuration for 480 kHz and 960 kHz SCS with short slot. In addition, Alt.2 requires a discussion on the rules that determine the BD/CCE limits for aligned and non-aligned spans between CCs. We don't know if the rules in Rel-16 are applicable to Alt.2, and defining new rules will take multiple meetings. Therefore, we support Alt1 which is aligned with a slot boundary, which has less standardization effort.  **Proposal 1: We support the fixed pattern of slot groups, which is aligned with a slot boundary.**  Since there does not seem to be a common understanding, we should first clarify the definition of Y. Y is the maximum number of consecutive slots that the UE monitors per slot-group consisting of X slots. After monitoring Y slots in one slot-group, the UE does not monitor during the X-Y slots until Y slots in the next slot group. For resolving the back-to-back problem, it was proposed in previous discussion that Y should be less than X/2 and always start at beginning of slot group. However, to avoid back-to-back problem, we only need to set a gap larger than X/2 between Y slots on the consecutive two slot-groups. This gap is secured by maintaining the location of Y slots within X slots across different slot groups, and floating Y slots improve the flexibility of MO distribution.  **Proposal 2: Y is the number of consecutive slots that the UE monitors PDCCH per slot-group consisting of X slots.**  **Proposal 3: Y slots should be floating, and the location within the X slots is maintained across different slot groups.**  At the 106-e meeting, X=4/8 slots were agreed upon as the minimum capability for 480kHz/960kHz SCS, in order to ensure the same processing performance on a time basis as single-slot monitoring at 120 kHz. On the other hand, some companies are of the opinion that smaller values of X should also be supported. However, X=4/8 allows for PDCCH monitoring at sufficiently short intervals, and the benefits of more frequent monitoring are currently not clear. Hence, a value of X smaller than X=4/8 should not be mandatory. If set as an optional capability, the BD/CCE budget should be considered. The first three symbols are set as the minimum requirement for CSS monitoring at 480 kHz and 960 kHz SCS, because the maximum duration of CORESET follows 3. If Y is too small, the flexibility of MO placement will be reduced, and if Y is too large, the microsleep opportunity may be lost. Therefore, Y should be set to 1, taking into account the impact on the specifications.  **Proposal 4: Values of X smaller than X=4/8 should not be mandatory. If values less than X=4/8 set as an optional capability, the BD/CCE budget should be considered.**  **Proposal 5: The following values should be used as basic settings.**   * **for 480 kHz SCS : X = 4, Y = 1** * **for 960 kHz SCS : X = 8, Y = 1** |

### R1-2112046 (LG)

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| In FR2-2, the multi-slot monitoring for 480/960 kHz SCS operates based on a fixed slot-group pattern, and the location of slot-group was determined to be aligned with the subframe boundary. The length of the slot-group is determined to be mandatory for X=4/8 for 480/960 kHz SCS, respectively, and other lengths may be supported as optional. In addition, the location where the monitoring occasion can be placed within the X slot-group may vary according to each SS set type. However, from the above agreement, BD/CCE budget can be reported by UE is common for all SS set types. Given that, the reported capability would indicate the BD/CCE budget within the common Y slots per slot-group, where the Y can be defined as Y=max(YGroup1, YGroup2) no matter how the value of YGroup2 is determined.  It can be seen that the SS set configuration for each SS set group has the following properties. First, the SS set corresponding to the Group (1) SS may be configured within YGroup1, and that corresponding to the Group (2) SS may be configured within YGroup2. In other words, BD attempts for each SS set group, i.e., Group (1) or Group (2) SSs, is restricted to fall within the YGroup1 or YGroup2 consecutive slots, respectively. Next, the location of Y consecutive slots within a slot-group of X slots should be kept constant across different slot groups. This is a necessary feature to avoid back-to-back monitoring issue. The spacing between adjacent Ys should be maintained at X slots (no matter Group (1) SS or Group (2) SS). When the slot index n0 associated with the SSB is changed due to UE movement, it may be necessary to adjust accordingly but it should be understood that the same pattern is repeated across the slot-groups not the location of Y maintains there forever. When the location of Y slots within a slot-group for Group (1) SS is changed due to n0 change, the corresponding location should be based on the location of YGroup2 slots for Group (2) SS such that the YGroup1 slots overlap the YGroup2 slots. That is, the change of n0 generates the same amount of time offset regardless of Group (1) SS or Group (2) SS. In summary, according to the above agreement, YGroup1 and YGroup2 should have the same behavior except that the length and location in a slot-group can be defined differently. Moreover, when n0 is changed, the location of YGroup1 and YGroup2 may be changed based on the same time offset, and should overlap each other after the change. From this point of view, we don’t see the need to define two different Ys (i.e., YGroup1 and YGroup2) for different SS set groups. We believe that the use of the common Y for Group (1) SS and Group (2) SS is sufficient to support the multi-slot monitoring. In addition, even if n0 is changed, the location of the Y slot (or YGroup1 slot if YGroup1 and YGroup2 are both defined) may not be changed when it does not deviate from the current Y slot. Otherwise, the location of the Y slot in the slot-group should be changed based on n0. In this way, frequent changes of the Y location can be avoided.  **Proposal #1: Support the common Y consecutive slots within a slot-group for all SS sets, and Y consecutive slots within a slot group of X slots are located from a time offset within the slot group, where the time offset is determined based on slot index n0 for type0-PDCCH monitoring at least for PCell.**   * + **The location of Y slots within a slot-group may be changed only when the slot n0 (and/or slot n0+1) is deviated from the current location of Y slots.**   **Proposal #2: In order to ensure the flexible location of the Y consecutive slots within a slot-group to be determined based on slot n0, one of the followings should be supported.**   * + **Alt 1: Type-0 PDCCH monitoring should be enhanced such as monitoring in slot n0 and slot n0+X**   + **Alt 2: Consecutive Y slots should be defined in a wrap-around manner within a slot-group of X slots if any enhancement for Type-0 PDCCH monitoring is not supported**   RRC (re)configuration may be the simplest method for shifting the location of Y slots within a slot-group according to the change of n0. But, if it takes too much time to change the location of Y through RRC (re)configuration, a method through MAC-CE or DCI indication can also be considered. In this case, after the n0 change is triggered, the application delay should be considered from triggering n0 change to applying the change of Y location. After the UE recognizes that slot n0 associated with the best SSB is changed (or after the UE is configured/indicated with changed location of Y slots), the related processing time for UE or gNB may be required. Regardless of whether such change of Y location is UE-initiated or gNB-initiated event, the application delay for both UE and gNB may be useful. In this case, it should be specified how much application delay is required to change the location of Y slots within a slot-group.  **Proposal #3: For the operation of shifting the location of Y consecutive slots within a slot-group, at least RRC (re)configuration should be supported. On top of RRC (re)configuration, MAC-CE or DCI can be considered to indicate the updated location of Y consecutive slots. When the MAC-CE or DCI indication is applied to this operation, the application delay should be specified.**  **Proposal #4: Consider to configure X and Y (i.e. duration) based on UE capability**   * + **X=2 for 480kHz and X=2,4 for 960kHz**   + **Y should be determined with respect to X**     - **At least, Y=1 and Y=X/2 should be supported for all X.**     - **Others values are FFS.** |

### R1-2112097 (NTT DOCOMO)

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| Regarding supported Y values for Group (1) SSs, scheduling flexibility and UE complexity may be tradeoff, thus the Y value can be different depending on the UE capability. For example, Y=1 slot can be supported as mandatory to ensure the time separation between two consecutive Y slots for UE complexity reduction, and Y>1 slots can be supported optionally to provide scheduling flexibility for Group (1) SSs. For Group (2) SSs, as mentioned above, it is preferable to keep two consecutive slots monitoring for type0-PDCCH CSS, i.e., 2 or larger value(s) should be supported for Y. Based on above, Y value(s) for each option should be as follows:   * Option A-rev1: Y should be larger than 2 slot * Option A-FL1:   + YGroup1 can be different depending on UE capability   + YGroup2 should be larger than 2 slot * Option B-rev1: Y can be different depending on UE capability   Another discussion point is which OFDM symbols in Y slot can be monitoring occasion. It should follow the same way as Rel-15 to provide the same configurability as Rel-15 for Group (2) SSs, i.e., any symbol in a slot can be the monitoring occasion for Group (2) SSs but the restriction on monitored slot for Group (1) SS can be different depending on UE capability.  Based on the discussion above, our best preference is option B-rev1 considering better scheduling flexibility and less specification impact. By taking exact Y value(s) into account based on the discussion above, we propose the following updates for option B-rev1.  **Proposal 1: Support Option B-rev1 with the following update on “Supported values of Y”:**   * **The reported capability indicates the BD/CCE budget within X slots** * **For Group (1) SS**   + **A SS can be configured to be within Y consecutive slots within a slot group of X slots**   + **The location of the Y consecutive slots can be anywhere within a slot group of X slots**     - **FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity, and configured time offset within a slot group of X slots**   + **The location of the Y consecutive slots within a slot group of X slots is maintained across different slot groups**     - **BD attempts for all Group (1) SSs are restricted to fall within the same Y consecutive slots** * **For Group (2) SS**   + **A SS can be configured as per Rel-15, and monitoring locations with respect to slot groups are unrestricted**   + **BD attempts for Group (2) SSs occur in slots with index n0 and n0 + 1 as per Rel-15** * **Supported values of Y**   + **Y=1 slot and optionally as well Y=X/2 consecutive slots** * **OFDM symbols can be configured for monitoring within the Y slot(s) is**    + **For Group (1) SS: first 3 symbols as mandatory UE capability and any OFDM symbols depending on the UE capability**   + **For Group (2) SS: any OFDM symbols**   On the other hand, at the last meeting, option A-FL1 with some modifications was proposed to alleviate both the concerns about specification impact by the restriction on Group (2) SSs slot(s) and about back-to-back monitoring. Though it is not the best preference from our perspective, for the sake of progress, we can support option A-FL1 with the following modification revision in red:  **Proposal 2: Search space configuration for multi-slot PDCCH monitoring capability can be as follows (modified Option A-FL1 in the discussion of RAN1#106bis-e meeting):**   * **For Group (1) SS**   + **A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots**     - **FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity**   + **The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring**     - **FFS: Details of UE procedure for time offset determination, e.g., MAC-CE activation of a new TCI state associated with Group (2) SSs**   + **The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**   + **BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots** * **For Group (2) SS**   + **A SS is configured to be within YGroup2 = 2 consecutive slots within a slot group of X slots, i.e., slots n0 and n0 + 1 as per Rel-15**   + **~~The location of the Y~~~~Group2~~ ~~consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring~~**   + **The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)**   + ~~Y~~~~Group2~~ ~~=max(2, Y~~~~Group1~~~~) [Ericsson: Y~~~~Group2~~ ~~=2]~~ * **The reported capability indicates the BD/CCE budget within max(2, YGroup1) slots per slot group** * **Supported values of YGroup1**   + **YGroup1=1 slot and optionally as well Y=X/2 consecutive slots** * **OFDM symbols can be configured for monitoring within the Y slot(s) is**    + **For Group (1) SS: first 3 symbols as mandatory UE capability and any OFDM symbols depending on the UE capability**   + **For Group (2) SS: any OFDM symbols** * **FFS: SS dropping in case n0 changes (to avoid back-to-back monitoring exceeding the capability)**   As described in the agreement above, whether to support X=2 for 480 kHz SCS is captured as FFS. We think it would depend on whether to support Y=1 slot to avoid back-to-back monitoring issue for Group (1) SSs. For option A-rev1, Y is shared between Group (1) and Group (2) SSs, and the monitored slot for type0-PDCCH needs to be changed if Y=1 slot is supported. Thus, X=2 slot should not be supported for option A-rev1 considering specification impact for type0-PDCCH CSS. On the other hand, for option A-FL1 and B-rev1, Y=1 slot for Group (1) SSs can be supported without specification change for type0-PDCCH monitoring. Therefore, to avoid such specification change, X=2 slot can be supported for 480 kHz SCS if option A-FL1 or B-rev1 with Y=1 slot for Group (1) SSs is supported.  **Proposal 3: X=2 slot can be supported for 480 kHz SCS if search space configuration option A-FL1 or B-rev1 is supported for multi-slot PDCCH monitoring capability definition.** |

### R1-2112204 (Qualcomm)

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| Observation 1: PDCCH monitoring occasion dispersed over multiple slots within a slot group of X slots may adversely impact the power efficiency.  Therefore, for 480 kHz and 960 kHz SCSs, mandating a UE to monitor PDCCH in more than one consecutive slots in a slot group is not desirable. For Group (1) SS sets, if monitoring more than one PDCCH slot is necessary, it could be optionally supported for Group (1) SS sets per UE capability. For Group (2) SS sets, however, since CSS monitoring is mandated for all UEs, the requirement should be conservative and consecutive slot monitoring should be avoided.  Proposal 2: Monitoring of all Group (1) SS sets are restricted within YGroup1 consecutive slots within a slot group of X slots, where the value(s) of YGroup1 is per UE capability:   * **YGroup1 = 1 slot is the mandatory UE capability.** * **Other values of YGroup1, e.g., YGroup1 = X/2, is optionally supported.**   Proposal 3: Monitoring of all Group (2) SS sets are restricted within YGroup2 = 1 slot within a slot group of X slots.  Note that YGroup2 = 1 slot in Proposal 3 cannot be attained by the legacy Rel-15 SS set #0 design and, thus, a new design of SS set #0 will be discussed in Section 2.1.3. Also, locations of YGroup1 and YGroup2 will be discussed in Section 2.1.3.  Regarding the discussion on whether and how to align monitoring occasions of USS and CSS, our preference is still Option A. However, in order make a progress, we are willing to compromise with Option B if it is properly modified to reflect the proposals in this contribution. Consolidating the discussion in the previous sections, the following revision of Option B is suggested as a compromise, where the changes from the previous version in RAN1 #106bis-e are marked in red font.   |  | | --- | | * Option B-rev2   + The reported capability indicates the BD/CCE budget within X slots   + For Group (1) SS     - A SS can be configured to be within YGroup1 consecutive slots within a slot group of X slots     - The location of the YGroup1 consecutive slots can be anywhere within a slot group of X slots       * FFS: Details of RRC configuration of Group (1) SSs (periodicity, offset, duration), e.g., based on X-slot granularity, and configured time offset within a slot group of X slots     - The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups     - BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots   + For Group (2) SS     - A SS can be configured to be within YGroup2 consecutive slots within a slot group of X slots     - The location of the YGroup2 consecutive slots within a slot group of X slots is based on slot index n0 in association with an SSB as per Rel-15     - BD attempts for Group (2) SSs are restricted to one slot per slot group of X slots, i.e., YGroup2 = 1 slot       * Alt 1) slot n0 and slot n0+X       * Alt 2) slot n0 only   + The maximum number of monitored slots for PDCCH in a slot group is restricted to YTotal     - YTotal is per UE capability     - YGroup1+YGroup2 ≥ YTotal ≥ YGroup1 ≥ YGroup2 = 1 slot     - If the number of slots included in at least one of YGroup1 and YGroup2 exceeds YTotal, one of Group (1) and Group (2) shall be prioritized   + Supported the following values of Y’s     - For X = 8: (YGroup1, YGroup2, YTotal) = (1, 1, 1) and optionally (1, 1, 2), (4, 1, 4), (4, 1, 5)     - For X = 4: (YGroup1, YGroup2, YTotal) = (1, 1, 1) and optionally (1, 1, 2), (2, 1, 2), (2, 1, 3)     - For X = 2: (YGroup1, YGroup2, YTotal) = (1, 1, 1) and optionally (1, 1, 2) |   For multi-slot PDCCH monitoring discussed in the previous sections, the Type1 CSS with dedicated configuration has been assumed to be in Group (1). However, with multi-slot PDCCH monitoring, the monitoring occasions of Group (1) SS sets may be limited to YGroup1 (< X) slots and the location of YGroup1 may be different across UEs. Therefore, a common dedicated configuration of the Type1 CSS for all UE seems impossible. As a result, for multi-slot PDCCH monitoring, the plausibility of putting the Type1 CSS with dedicated RRC configuration within Group (1) should be reconsidered.  Observation 5: For multi-slot PDCCH monitoring, putting Type1 CSS with dedicated RRC configuration within Group (1) may be infeasible and should be reconsidered.  To address the issue, Type1 CSS with dedicated RRC configuration (i.e., other than SS set #0) can be separated from Group (1) toward a new group, e.g., Group (3). For monitoring Group (3) SS sets, a special rule for determining a MO within a slot group may be applied. For example, Type1 CSS may be configured with one-slot periodicity, commonly for all UEs, so that every slot in the slot group may include a MO for Type1 CSS. Then, to monitor the Type1 CSS with dedicated RRC configuration, each UE may select only one slot out of the X slots in the slot group. A simple rule for selecting the slot can be as follows:   * Connected mode UE: select a slot for Type1 CSS monitoring that falls in YGroup1 slot(s) of the UE. * Idle/inactive mode UE: a slot offset (0,..,X-1 slots) is associated with a RACH resource/preamble, and the slot for Type1 CSS monitoring is selected based on the RACH resource/preamble that the UE used for the RACH procedure. |

### R1-2112301 (MediaTek)

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| One remaining discussion is whether and how to restrict PDCCH monitoring in a consecutive Y slots within a slot group of X slots. In RAN1 #106bis e meeting, there was a discussion on the feasibility of Type-0 PDCCH configuration under Alt1 framework for UEs located within different gNB TX beams and for UEs moving to different gNB TX beams. In particular, for a UE moving into different TX beams from gNB perspective, the UE can be configured to monitor Type-0 CSS in different time domain occasions, which might not be confined within a fixed Y consecutive slots within a slot group together with other SS sets. Our view on the issue is as follows.  First of all, we would like to clarify that the above changing monitoring occasions behavior associated with UE mobility is only applied to the case when *searchSpaceID*=0 for Type-0 CSS. If *searchSpaceID* is not zero for Type-0 CSS, there is no need to change monitoring occasion for Type-0 CSS associated with UE mobility. Secondly, to address the issue when *searchSpaceID*=0 for Type-0 CSS, two alternatives can be considered under the framework of the same fixed pattern of slot groups:  Alternative 1) The location of the Y slots within the X slots is fixed across slot groups and Type-0 CSS configuration needs to be revised accordingly.  Alternative 2) The location of the Y slots within the X slots is fixed across slot groups and Type-0 CSS monitoring can be located outside the Y slots.  From UE perspective, Alternative 1) is preferred due to the benefit of power saving and restriction on the back-to-back monitoring. The consequence of adopting Alternative 1) is the Type-0 CSS monitoring revision. However, one simple modification to limit spec impact is simply changing the monitoring slot index formula in TS 38.213 Clause 13 to where X =4 or 8 for 480kHz and 960kHz, respectively. On the other hand, Alternative 2) has less spec impact on Type-0 CSS monitoring at the cost of UE PDCCH monitoring complexity compared to Alternative 1).  **Proposal 1: For restrictions on PDCCH monitoring within a slot group, adopt one of the following alternatives**   * **Alternative1: The location of the Y slots within a slot group of X slots is fixed across slot groups**   + **BD/CCE budget is defined per Y slots within a slot-group**   + **FFS: search space sets with *searchSpaceID*=0 configuration modification, e.g., revising monitoring slot index to be** * **Alternative 2: The location of the Y slots within a slot group of X slots is fixed across slot groups and search space sets with *searchSpaceID*=0 monitoring can be located outside the Y slots.**   + **BD/CCE budget is defined per slot-group of X slots** |

## Topic A2: Search Space Configuration/Enhancement

### R1-2110828 (Huawei, HiSilicon)

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| 1. ***For search space set configuration for multi-slot PDCCH monitoring, the unit of “periodicity” should be changed to X slots, with default value X=4 for 480 kHz and X=8 for 960 kHz.*** 2. ***For search space set configuration for multi-slot PDCCH monitoring, the parameter “offset” should be re-interpreted as follows:***  * ***If the Group (1) SS is determined independently of Group (2) SS, which is preferred, then the unit of “offset” is changed to X slots, with default value X=4 for 480 kHz and X=8 for 960 kHz, and an additional slot level offset or extension of monitoringSymbolsWithinSlot is required if monitoring occasions are within the Y>1 slots in an X-slots.***  1. ***For search space set configuration for multi-slot PDCCH monitoring, the unit of “duration” should be changed to X slots, with default value X=4 for 480 kHz and X=8 for 960 kHz SCS.*** 2. ***SSSG switching can be supported between two different periodicities of multi-slot-based monitoring in order to save UE power consumption on PDCCH monitoring.*** |

### R1-2110873 (Futurewei)

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| The time pattern for monitoring PDCCH is configured to a UE by means of search space (SS) sets: common SS (CSS), and UE specific SS (USS). A UE can be configured up to 10 SS sets for each up to four BWPs in a serving cell. The SS set configuration indicates SS type, DCI format(s), monitoring occasions and the number of PDCCH candidates for each aggregation level (AL) in the SS set. A search space is associated with only one CORESET. A control-resource set consists of resource blocks in the frequency domain and symbols in the time domain. A UE monitors a set of PDCCH candidates in one or more CORESETs on the active DL BWP.  The UE determines what slots to monitor based on the duration, periodicity and offset provided by higher layers. TS 38.331 defines the SearchSpace IE.   * *duration* is the number of consecutive slots that a SearchSpace lasts in every occasion, i.e., upon every period as given in the SlotPeriodicityAndOffset. * *monitoringSlotPeriodicityAndOffset*: number of slots for PDCCH Monitoring configured as periodicity and offset.   With Rel 17, the basic pattern is extended to multiple slots, therefore the specified duration is a repetition of the basic pattern and should be a multiple of the basic pattern length. The basic pattern duration in multi-slot PDCCH monitoring corresponds to X value above. The basic pattern duration for multi-slot PDCCH monitoring consists of an active search period (span) and a period where UE can microsleep (X-Y for instance).  With multi-slot PDCCH monitoring new variables are necessary to describe the extended basic monitoring pattern within a search space duration.   * *spanDuration*, represents the number of slots of span duration where PDCCH may be localized * *patternDuration,* which correspond to X value duration   We note that the existing elements (variables) for search space configuration should keep their definition as the extended basic monitor pattern is repeated for “duration” slots, (duration >X), with periodicity and offset configured as presented in Figure 4.    Figure 4, Search Space timing    In a multi-slot monitoring span UE may be provided with bitmap that indicates the monitoring symbols in each span. We note that this information is already provided in the Rel-15/16 IE by the variable *monitoringSymbolsWithinSlot*, which is the first symbol(s) for PDCCH monitoring in the slots configured for PDCCH monitoring. For instance, UE will monitor just the first 3 symbols in each slot of the multi-slot span X=1. Moreover, the PDCCH schedule and monitoring can be further simplified if the CSS and USS are grouped and scheduled at different time either in the same slot or different slots of the span.  We note that is possible to select between two PDCCH different monitoring behaviors (e.g. per slot vs per multi-slot or per 2 slots vs 4 slots monitoring) through search space set group (SSSG) switching.  As presented in the Figure 4, a particular case for minimum configurable periodicity of the USS and Type3-PDCCH CSS may be the smallest value X that a UE supports. Therefore, we support the following proposal from [4]:  **Proposal 7: For each SCS 480 kHz and 960 kHz, the minimum configurable periodicity of the USS and Type3-PDCCH CSS is the smallest value X that a UE supports when reporting its multi-slot PDCCH monitoring capabilities for the corresponding SCS.** |

### R1-2110999 (vivo)

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| In NR Rel-15&16, the allowed SS period configuration is from 1 slot to 2560 slots as shown below [9]. When PDCCH uses 480/960K SCS, there are the following two issues to be considered:   * Smaller SS period (e.g. 1 or 2 slots) is not needed for 480/960K SCS with multi-slot-based capability; * The largest configurable SS period, i.e. 2560 slots=80/40ms for 480/960K SCS respectively, is not enough for SS configuration.     **Proposal 8: Search space configuration should be improved for 480K/960K SCS.** |

### R1-2111075 (ZTE, Sanechips)

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| If a fixed pattern of slot groups to define the new capability for PDCCH monitoring is adopted, when configuring the search space set by higher layer parameter *monitoringSlotPeriodicityAndOffset*, the gNB needs to ensure that PDCCH monitoring periodicity , the duration *TS* is an integral multiple of X slots (X slots consists a slot group), or is an integral multiple of slot groups, i.e. and *TS* are in the units of slot group. For example, if a slot group includes four slots (X=4), the duration *TS* can be configured as 4, 8, 12, 16, ... of slots. Alternatively, the duration *TS* can be configured as 1, 2, 3, 4, ... of slot groups, i.e. the basic granularity of the duration *TS* should be defined as a slot group. Figure 3 gives one configuration type in a slot group, e.g., PDCCH MO is configured in the first slot within the slot group.  Besides, the location of Type0-PDCCH CSS set’s monitoring slots relies on the SS/PBCH block of the UE. If the location of Y consecutive slots within X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) SS monitoring, a new slot level bitmap needs to be introduced to indicate which slots have monitoring occasions for SCS 480/960 kHz.    **Figure 3: Configurations if a fixed pattern of slot groups is supported**  Multiple PDSCH/PUSCH scheduling with a single DCI being discussed in agenda item 8.2.5 can not only save DCI overhead, but also reduce PDCCH monitoring frequency without sacrificing scheduling flexibility. Therefore, the design of the new UE capability for PDCCH monitoring, search space set configuration can be considered in combination with multiple PDSCH/PUSCH scheduling by a single DCI.  **Proposal 5: If multi-slot PDCCH monitoring based on slots within a slot group is supported, PDCCH monitoring periodicity and the duration *TS* of the search space sets should be configured as an integral multiple of a slot group. Also, a new slot level bitmap needs to be introduced to indicate which slots have monitoring occasions.**  Search Space Set Group (SSSG) Switching was introduced in Rel-16 NR-U. In order to reduce access delay and save power, the SSSG monitoring periodicity/granularity is increased or decreased according to the channel access procedure. UE has to support frequent PDCCH monitoring outside gNB-COT and infrequent PDCCH monitoring inside COT. The existing SSSG switching is applied for SCS 15/30/60 kHz, for SSSG switching on large SCS values like 120, 480 and 960 kHz, UE needs to dynamically change between two PDCCH monitoring periodicity/granularity. SSS switching operation is also related to whether per slot PDCCH monitoring is supported. Besides, the switching time with all SCSs supported in above 52.6 GHz needs to be defined if SSSG switching is agreed to be supported.  **Proposal 6: Support SSSG switching for SCS 120/480/960 kHz, and the following points can be further studied:**   * **SSSG switching between two different periodicities of multi-slot PDCCH monitoring or between multi-slot and per-slot monitoring if per-slot monitoring is supported for 480/960 kHz** * **The switching time with all SCSs supported in above 52.6 GHz**   For the newly introduced SCS i.e. 480/960 kHz in Rel-17 NR above 52.6 GHz, the length of the slot/symbol becomes shorter. Given the current CORESET configuration in Rel-16, the PDCCH is transmitted on up to 3 OFDM symbols which are quite short and limited. In addition, since a single DCI can schedule multiple PDSCH/PUSCH over multi-slot PDCCH monitoring slots, the DCI transmission reliability is essential to the data transmission efficiency and system performance. Therefore, we suggest considering a duration of more than 3 OFDM symbols for 480/960 kHz SCS since it is beneficial for improving PDCCH coverage and PDCCH monitoring capability.  **Proposal 10: Considering a duration of more than 3 OFDM symbols for PDCCH with 480/960 kHz SCS in Rel-17 NR above 52.6 GHz.** |

### R1-2111092 (Spreadtrum)

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| Many of the UE capabilities are already numerology dependent and the “slot” is commonly used as a reference time grid to confine the capabilities. On the other hand, if the UE is expected to monitor PDCCH in every slot, the micro-sleep opportunities decrease due to the short slot length for the high SCS and the power efficiency during the connected mode would be degraded. Therefore, for the high SCSs, multi-slot can be considered to confine the UE capabilities. In conclusion, it is desirable to support both single-slot and multi-slot PDCCH monitoring capabilities for different SCSs.  Each search space set group may be configured for either single-slot or multi-slot PDCCH monitoring. In unlicensed band, if the band is detected as free, it is better to transmit the PDCCH frequently since the will help UE to access the unlicensed spectrum as soon as possible. However, when the unlicensed band is busy, a sparse PDCCH monitoring occasion is helpful to the power saving. Therefore, search space set group switching will provide more dynamic transition between single-slot and multi-slot PDCCH monitoring, therefore, we slightly prefer to support it. As suggested by the FL, this issue can be discussed after progress on BD capability and N1 timeline. |

### R1-2111242 (CATT)

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| In Rel-15/16, the parameter *monitoringSymbolsWithinSlot* indicates the distribution of MOs within each slot and the length of bitmap is 14. For 480 kHz SCS and 960 kHz SCS, the bitmap with 14bit is not sufficient to indicate the distribution of MO within X-slots. We suggest adding a new bitmap indicating the slots that the search space exists within the multi-slot by *monitoringSlotWithinMulti-Slot*. Thus, the first symbol of the CORESET within multi-slot for PDCCH monitoring can be jointly indicated by the *monitoringSymbolsWithinSlot* and *monitoringSlotWithinMulti-Slot*. It should be noted when the search space exists in multiple slots within multi-slot, the distribution of MOs within each slot is the same.  For example, if the UE is provided the following parameter by *SearchSpace*, the PDCCH monitoring will be as shown in Figure 2:   * *monitoringSlotPeriodicityAndOffset:* the periodicity of search space set is 16 slots and the offset is 0. * *duration*: the unit of the duration is the multi-slot, the value of the duration is 2. * *monitoringSymbolsWithinSlot*: the bitmap of the first symbol MO within each slot is 10001000000000. * *monitoringSlotWithinMulti-slot*: the bitmap of the slots that the search space exists is 1100. * The same span pattern repeats in every slot.     Figure 2: Search space set configuration for 480 kHz SCS  ***Proposal 2：For 480 kHz SCS and 960 kHz SCS, the search space configuration can be enhanced as follows.***   * ***Modifying the value of monitoringSlotPeriodicityAndOffset to the integer of the X-slots.*** * ***Extending the unit of duration from slot to X-slots indicating a number of consecutive multi-slot that the search space exists.*** * ***Adding a new bitmap monitoringSlotWithinMulti-slot indicating the slot that the search space exists within the multi-slot.***     Figure 3: Search space group switching for 60GHz NR-U  The search space group set switching was introduced in Rel-16 NR-U with 15 kHz SCS, 30 kHz SCS and 30 kHz SCS for dynamic switching between different search spaces. Before the gNB obtains the COT, the frequent monitoring enable the gNB to transmit DCI as soon as possible if gNB’s LBT is successful. However, frequent monitoring is not conducive to power saving of the UE during the COT. When the search space group set switching is configured, the gNB can indicate to UE switching between a search space with long periodicity and a search space with short periodicity to meet different scheduling requirements. Therefore, we suggest the legacy SSSG switching mechanism should be reused for the 120 kHz SCS, 480 kHz SCS and 960 kHz SCS in 60GHz NR-U, as shown in Figure 3.  ***Proposal 3: The Legacy SSSG switching mechanism should be reused for the 120 kHz SCS, 480 kHz SCS and 960 kHz SCS in 60 GHz NR-U.***  It has been agreed that the BD/CCE budget for 120 kHz SCS in 52.6-71 GHz is the same as that for 120 kHz in FR2. Thus, we believe 120 kHz SCS in 52.6-71 GHz doesn’t support the monitoring capability of the span defined in Rel-16 just like 120 kHz in FR2. The PDCCH monitoring capability for 120 kHz SCS is the baseline for study of the PDCCH monitoring capability for 480 kHz SCS and 960 kHz SCS. The motivation to support single slot PDCCH monitoring capability for 480 kHz SCS and 960 kHz SCS out of the COT is not clear. It is not necessary to enhance the SSSG switching to support dynamic switching between single slot PDCCH capability and multi-slot PDCCH capability for 480 kHz SCS and 960 kHz SCS.  ***Proposal 4: SSSG switching is not required to be enhanced to support the switching between single slot PDCCH capability and multi-slot PDCCH capability 480 kHz SCS and 960 kHz SCS.*** |

### R1-2111386 (Sony)

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| For multi-slot monitoring, there also had been some discussions from RAN1#104 on monitoring location and duration of OFDM symbols:   |  | | --- | | Further discussion on multi-slot span capabilities, monitoring periodicities, corresponding number and location of OFDM symbols for Cases 1-1 and 1-2.   * Case 1: PDCCH monitoring of all SS sets monitored in a slot occurs within 3 consecutive OFDM symbols that have fixed positions in each slot   + Case 1-1: PDCCH monitoring limited to within first three OFDM symbols of a slot   + Case 1-2: PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot     - For a given UE, all search space configurations are within the same span of 3 consecutive OFDM symbols in the slot * Case 2: PDCCH monitoring cases other than Case 1 |   With a limited location of PDCCH monitoring, Case 1-1 is simple for realization, while Case 1-2 is more flexible for gNB scheduling. Thus, we suggest Case 1-1 can be the baseline, and Case 1-2 can be discussed with further benefits evaluation of flexible scheduling.  **Proposal 1 : PDCCH monitoring limited to within the first several OFDM symbols of a slot can be supported as the baseline.**  As aforementioned, large SCSs with 480kHz and 960kHz cause a relatively short time duration of a symbol. Therefore, if CORESET duration remains up to 3 symbols as in R16, the real-time duration for PDCCH monitoring is quite small, which also puts extra time limitation of UE blind decoding. Therefore, we suggest a large CORESET duration with more than 3 symbols for SCS 480kHz and 960kHz alleviate UE processing capability for PDCCH decoding. Thus, we suggest PDCCH monitoring with a maximum duration of more than 3 OFDM symbols per PDCCH monitoring occasion.   1. **: If CORESET duration remains up to 3 symbols as in R16, the real-time duration for PDCCH monitoring is quite small due to the short symbol duration with large SCS.**   **Proposal 2: PDCCH monitoring with a maximum duration of more than 3 OFDM symbols per PDCCH monitoring occasion is more suitable.**  For multi-slot PDCCH monitoring, an agreement was achieved in RAN1#106-bis-e meeting. Multi values of X and Y have been discussed there and probably will be continuously discussed in this meeting. From our perspective, multi values of X and Y benefit the flexibility of search space configuration for NW and the adjustment of power consumption for UE, so we are supportive of multi (X,Y) capacity definition. However, with multi (X,Y) capacity, another issue on SSSG switching among different multi-slot monitoring capacities needs to be considered.  Moreover, there were also discussions in previous meetings on whether to apply multi-slot PDCCH monitoring at all times and for all search spaces. That is to say, there could be a possibility for some SSS not supporting multi-slot PDCCH monitoring, and several companies had also proposed to support per-slot monitoring. If per-slot monitoring is supported for high SCS, SSSG switching between different types of monitoring capacities should also be considered.   |  | | --- | | Agreement:(RAN1#106e)   * A UE supporting 480 kHz SCS supports multi-slot PDCCH monitoring for 480 kHz SCS. * A UE supporting 960 kHz SCS supports multi-slot PDCCH monitoring for 960 kHz SCS. * FFS: whether to apply multi-slot PDCCH monitoring at all times and for all search spaces. |   One possible scheme to address the above SSSG switching issues is to configure the search space set with monitoring capacity indices. The procedure can be as follows:   * First, when UE reports multi-monitoring capabilities, the corresponding monitoring capability indices are also reported. * Then, gNB configures each SSS with the associated monitoring capability index. * After SSSG switching is trigged, such as the scheduling requirement from gNB or power-saving requirement from UE by preferred monitoring capacity index reporting, a DCI with monitoring capability index indication is scheduled so that UE can switch to the specified SSSG for monitoring.   **Proposal 3: SSSG switching should be considered if multi-slot monitoring capacity with multiple (X,Y) or monitoring capacity with multiple types are supported.** |

### R1-2111464 (Ericsson)

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| To align the slots containing monitoring occasions within a slot group of size for both Group (1) and Group (2) search spaces, the RRC configuration for Group (1) search spaces provides at least   * periodicity in terms of X-slot groups * offset in terms of X-slot groups within the period * duration in terms of X-slot groups within the period * *monitoringSymbolsWithinSlot*   With the X-slot group boundary definition presented in the last section, the monitoring slot(s) within a X-slot group for a Group (1) search space always locate(s) at the beginning of a X-slot group. Hence, there is no need to provide a monitoring slot offset within slot group in the RRC configuration if Ygroup1 = 1.  One simple approach to enable the periodicity, offset and duration for search space configuration in unit of slots is to reinterpret existing RRC fields *monitoringSlotPeriodicityAndOffset* and *duration* as in unit of slots when multi-slot PDCCH monitoring is in effect. Alternatively, of course, it is also possible to define new Rel-17 RRC fields to explicitly define these quantities in units of X-slots, if so desired.  With this, the UE determines a PDCCH monitoring occasion for search space in slot with index in a frame with index if  For a slot carrying monitoring occasions for the search space, the exact monitoring symbols within the slot are determined according to the current specs based on the existing *monitoringSymbolsWithinSlot* field.   1. For multi-slot PDCCH monitoring with 480/960 kHz SCS, the network configures a search space with at least:    1. periodicity in terms of X-slot groups,    2. offset in terms of X-slot groups within the period,    3. duration in terms of X-slot groups within the period, and    4. *monitoringSymbolsWithinSlot*. 2. For operation with 480/960 kHz SCS multi-slot PDCCH monitoring with slot group size of X, existing RRC search space configuration fields    1. *monitoringSlotPeriodicityAndOffset* is re-interpreted as providing the periodicity in terms of X-slot groups and offset in terms of X-slot groups within the period;    2. *duration* is re-interpreted as providing the duration in terms of X-slot groups within the period. 3. For operation with 480/960 kHz SCS multi-slot PDCCH monitoring with slot group size of X, the UE determines that a PDCCH monitoring occasion for search space in Group (1) is in slot with index in a frame with index if   where , , and are the configured periodicity, offset and duration of the search space in terms of X-slot groups, and is the slot group grid offset.  If RAN1 agrees on Ygroup1 ≥ 2, a new RRC field *extraSlotOffsetWithinSlotGroup* can be introduced to configure additional slot offset within a slot group, . With this, the UE determines a PDCCH monitoring occasion for search space in slot in a frame with number if  If Ygroup1 is always restricted to be no more than 2, the new RRC field *extraSlotOffsetWithinSlotGroup* can be a binary value or simpler (since if *extraSlotOffsetWithinSlotGroup* is not provided in the search space configuration).   1. If Ygroup1 ≥ 2, for operation with 480/960 kHz SCS multi-slot PDCCH monitoring with slot group size of X, if the UE is provided with a configuration of an additional slot offset within a slot group, , for a search space , the UE determines that a PDCCH monitoring occasion for search space in Group (1) is in slot with index in a frame with index if   where , , and are the configured periodicity, offset and duration of the search space in terms of X-slot groups, and is the slot group grid offset.   1. In defining a solution for Rel-17 multi-slot PDCCH monitoring, both intra- and inter-slot monitoring aspects shall be addressed jointly:    1. In which and in how many slot(s) of a multi-slot span shall PDCCH be monitored?    2. In which OFDM symbols of a monitored slot shall PDCCH be monitored?   **Case of Ygroup1 ≤ 1 slot**  If PDCCH monitoring is restricted to one slot within each X-slot window, it becomes necessary to utilize more OFDM symbols in the slot to multiplex different UEs on CORESETs with different time locations as illustrated in Figure 4 below. A UE will need to be able to monitor CSS in one CORESET and USS in a different CORESET that are not necessarily contiguous in time, either. That is, intra-slot Case 2 monitoring capability support (Rel-15 FG 3-5) will be mandatory if Ygroup1 ≤ 1 slot. This is because the UE may also need to monitor the CSS and USS in the same slot and the SS may be separated by more than three OS span allowed in intra-slot Case 1-2.   1. For multi-slot PDCCH monitoring with 480/960 kHz SCS, it is mandatory for the UE to support intra-slot PDCCH monitoring capability Case 2 (Rel-15 FG 3-5) if Ygroup1 ≤ 1 slot.   **Case of Ygroup1 > 1 slot**  If more than one slot within each X-slot window is available for the network to distribute the USS for different UEs across different slots, PDCCH load congestion can be avoided while accounting for the latency requirements of the UEs. This is illustrated in Figure 5. Furthermore, with additional PDCCH resource across multiple slots, intra-slot monitoring capability according to Rel-15 FG 3-1 can be set as the minimum requirement.   1. For multi-slot PDCCH monitoring with 480/960 kHz SCS, intra-slot PDCCH monitoring capability according to Rel-15 FG 3-1 can be considered as the minimum UE requirement if Ygroup1 > 1 slot. 2. For multi-slot PDCCH monitoring with 480/960 kHz SCS, configuration of Group (2) search spaces follows Rel-16 specs. 3. For multi-slot PDCCH monitoring with 480/960 kHz SCS, monitoring occasions of Group (2) search spaces are within Ygroup2 = 2 consecutive slots within a slot group.   In Rel-16, search space set group (SSSG) switching was introduced for handle the necessary LBT procedures for shared spectrum access in the FR-1. Many sources had discussed support of SSSG switching for 480/960 kHz SCS cells. Some sources considered the support as a natural extension of the Rel-16 functionalities and an explicit agreement of support may not be needed. All that is needed is the definition of a proper minimum switching time. Other sources considered the potential complications if different SSSGs are configured with different slot group sizes.  Our view is that there is no need to spend valuable RAN1 time on additional changes or enhancements. Furthermore, if only X=4 for 480 kHz SCS and X=8 for 960 kHz SCS are supported, the functionality of the SSSG switching is also straightforward for 480/960 kHz SCS.   1. Enhancements to Rel-16 search space set group (SSSG) switching is of low priority for Rel-17 NR operation in the above 52.6 GHz range. The Rel-16 functionality can be supported for a 480/960 kHz SCS cell without additional enhancement if RAN1 can agree on the corresponding minimum switching times. |

### R1-2111484 (Intel)

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| The search space set group (SSSG) switching as defined NR-U is shown in Figure 1. The frequent PDCCH monitoring is assumed before gNB gets the channel occupation. For example, search space set with mini-slot level or slot-level PDCCH monitoring can be configured, which is the first search space set group (SSSG). The frequent PDCCH monitoring reduces the delay for gNB to start DL transmission immediately after the LBT is successful. On the other hand, after gNB starts a COT, a second SSSG is configured, which may contain infrequent PDCCH monitoring for power saving. The DL performance for the second SSSG is guaranteed by the configuration of more PDCCH candidates with same or different DCI format in each MO of the second SSSG.    **Figure 1: SSSG switching in NR-U**  Dynamic SSSG switching provides a means to balance the fast channel access right after LBT is successful and effective scheduling and power saving after the COT is obtained. The feature is useful for FR2-2 too. The configured search space configuration in the two SSSGs has different requirements on the PDCCH monitoring capability. In general, two options can be considered. In summary, UE needs to dynamically change its PDCCH monitoring capability together with SSSG switching.   * Option 1: switching between per-slot PDCCH monitoring capability and multi-slot PDCCH monitoring capabilities * Option 2: switching between two multi-slot PDCCH monitoring capabilities   **Proposal 9:**   * Dynamic SSSG switching is supported for all SCSs 120, 240 and 960kHz. * The search space set configurations of the two SSSG can correspond to two different PDCCH monitoring capabilities   In NR, a search space (SS) set could be configured for the UE to monitor PDCCH. Up to 10 SS sets can be configured for each DL BWP in a serving cell. The time domain pattern of a SS set is configured by the following RRC parameters  - a PDCCH monitoring periodicity of slots and a PDCCH monitoring offset of slots, by *monitoringSlotPeriodicityAndOffset*  - a PDCCH monitoring pattern within a slot, indicating first symbol(s) of the CORESET within a slot for PDCCH monitoring, by *monitoringSymbolsWithinSlot*  - a duration of slots indicating a number of slots that the search space set exists by *duration*  Specifically, 3 cases for SS set configuration within a slot are supported by parameter *monitoringSymbolsWithinSlot*,   * Case 1: PDCCH monitoring of all SS sets monitored in a slot occurs within 3 consecutive OFDM symbols that have fixed positions in each slot   + Case 1-1: PDCCH monitoring limited to within first three OFDM symbols of a slot   + Case 1-2: PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot     - For a given UE, all search space configurations are within the same span of 3 consecutive OFDM symbols in the slot * Case 2: PDCCH monitoring cases other than Case 1   Case 1-1 is the basic PDCCH monitoring occasion(s) in the beginning of a slot, which should be supported for high SCS. Case 2 is to configure more frequent PDCCH MOs within a slot, which is targeted to reduce scheduling latency. This is important especially for low SCS, e.g. 15kHz or 30kHz. On the other hand, it is not necessary for a high SCS, e.g. 480kHz or 960kHz, given that the slot length is quite short, i.e. 1/32ms or 1/64ms. In this case, there is no clear motivation to allow full flexibility on the positions of PDCCH MO(s) in a slot, i.e. Case 2. Therefore, restriction on PDCCH MOs in a slot can simplify UE implementation without performance degradation. Note: even when Case 2 is not supported, it is still possible that Type0/0A/1/2 CSS sets can be configured in different positions, e.g., symbol 0 and/or symbol 7 in a slot, which is similar to FG 3-1.  **Proposal 10:**   * On the PDCCH monitoring occasion in a slot   + Case 1-1 and Case 2 are supported for SCS 120kHz   + For SCS 480kHz and 960kHz, only Case 1-1 is supported.     - Type0/0A/1/2 CSS sets can be configured in different positions, e.g., symbol 0 and/or symbol 7 in a slot, which is similar to FG 3-1   **Proposal 11:** To support the adaptation of the position of the Y consecutive slots in a X-slot group   * PDCCH MOs of a SS set can be configured in the X slots of a X-slot group. * A UE only monitors the MOs of the SS set which is overlapped in the current Y slots of the X-slot group.   In existing NR, a SS set can be configured by high layer parameters *monitoringSlotPeriodicityAndOffset,* *duration* and *monitoringSymbolsWithinSlot*. For SCS 480kHz/960kHz, *monitoringSlotPeriodicityAndOffset* and *duration* can be configured as multiple of X slots. As proposed in Proposal 11, *monitoringSymbolsWithinSlot* may be extended to X slots. As proposed in Proposal 2, Case 2 is not preferred. Consequently, it is not necessary to use a bitmap of 14\*X bits for the pattern of MOs in X slots. A bitmap of 2\*X bits can be sufficient to allow a Type0A/1/2 CSS sets to align with MO of Type0 CSS sets in symbol 0 and/or 7 in a slot.  **Proposal 12: For the SS set configuration,**   * *monitoringSlotPeriodicityAndOffset* and *duration* can be configured as multiple of X slots. * *monitoringSymbolsWithinSlot* can be extended to X slots. A bitmap of 2\*X bits is sufficient. |

### R1-2111563 (Xiaomi)

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| ***Summary 1: To make sure Group (1) SS and Group (2) SS fall into the same Y slots within a X slot group, gNB has to guarantee,***   1. ***The periodicity of Group (1) SS should be integer factor or multiple of the periodicity of Group (2) SS, and*** 2. ***X should be equal to the minimum SS periodicity of Group (1) SS and Group (2) SS, otherwise, a floating Y is needed***   Search space set group switching is introduced in R16 NR-U for power saving propose and group switching time is defined for SCS 15-60kHz. To facilitate unlicensed band operation for NR 52.6-71GHz, group switching time should also be defined for 120/480/960kHz  ***Proposal 6: Search space set group switching time***  ***should be defined for 120/480/960kHz.***  The maximum search space periodicity in current spec is 2560 slots, and with SCS increased to 960kHz, the absolute time of the maximum search space periodicity will be decreased by 8 times. So new periodicity parameters may need to be introduced for the new SCSs, as well as the search space offset/duration parameters.  ***Proposal 7:*** ***New search space periodicity parameters, as well as the search space offset/duration parameters, may need to be introduced for the new SCSs.*** |

### R1-211642 (Lenovo, Motorola Mobility)

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| In our view, if new DCI format can be agreed to be supported for high SCS values such as 480kHz and 960kHz, then PDCCH monitoring can be further reduced by restricting the need for UE to monitor other DCI formats for scheduling DL/UL such as DCI format 0\_1 and format 1\_1. If such restriction is supported, then the number of blind detections for a UE can be significantly reduced or at least not expected to increase from the current UE capabilities.  ***Proposal 3: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, if a new DCI is agreed to schedule multiple PDSCH/PUSCH, then restrictions on monitoring of other DCI formats (such as DCI format 0\_1/1\_1) should be supported i.e., search space set configuration with restricted combination of DCI formats should be supported to not increase the number of blind decodes***  Furthermore, with high SCS values, the absolute duration of the slot is greatly reduced and moreover, when single DCI can schedule multi-PDSCH/PUSCH over multiple slots, it might be beneficial to consider longer duration than 3 symbols for CORESETs. Multiple benefits can be associated with longer duration:   * Better support for higher aggregation levels for better reliability * More resources available for CORESET, but with same or even reduced duration in absolute time * More symbols available to allow TDM multiplexing between DM-RS and control information   + Benefit of a DM-RS symbol with continuous frequency resources will account for better channel estimation with higher SCS values.   In fact, for very high SCS value such as 960kHz, even an entire slot for PDCCH can be considered to allow for only single PDCCH monitoring occasion within a slot.  ***Proposal 4: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, CORESET duration longer than 3 symbols should be supported:***   * ***FFS: Maximum duration up to 14 symbols in a slot***   ***Proposal 5: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, CORESET structure with only TDM between the DM-RS symbols and control information should be supported*** |

### R1-2111673 (Transsion Holdings)

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| In NR, the PDCCH monitoring occasion can be configured by RRC parameter “*SearchSpace*”, which is listed below.  SearchSpace ::= SEQUENCE {  searchSpaceId SearchSpaceId,  controlResourceSetId ControlResourceSetId OPTIONAL, -- Cond SetupOnly  monitoringSlotPeriodicityAndOffset CHOICE {  sl1 NULL,  sl2 INTEGER (0..1),  sl4 INTEGER (0..3),  sl5 INTEGER (0..4),  sl8 INTEGER (0..7),  sl10 INTEGER (0..9),  sl16 INTEGER (0..15),  sl20 INTEGER (0..19),  sl40 INTEGER (0..39),  sl80 INTEGER (0..79),  sl160 INTEGER (0..159),  sl320 INTEGER (0..319),  sl640 INTEGER (0..639),  sl1280 INTEGER (0..1279),  sl2560 INTEGER (0..2559)  } OPTIONAL, -- Cond Setup  duration INTEGER (2..2559) OPTIONAL, -- Need R  monitoringSymbolsWithinSlot BIT STRING (SIZE (14)) OPTIONAL, -- Cond Setup  Regarding the parameter of “monitoringSlotPeriodicityAndOffset” in “*SearchSpace*”, in NR Rel-15 it means the slots for PDCCH monitoring configured as periodicity and the relevant offset. For each slot group, it is better to restrict the PDCCH monitoring occasions within Y slots. Otherwise, the multi-slot PDCCH monitoring capability will be violated. Therefore, the parameter of period in “*SearchSpace*” should be an integer multiple of X. Meanwhile, to ensure the PDCCH monitoring occasions are located within the Y slots, the offset values in “*SearchSpace*” should be associated with the position of Y slots within a slot group.  Regarding the parameter of duration in “*SearchSpace*”, in NR Rel-15 it refers to the number of consecutive slots that a “*SearchSpace*” lasts in every period. However, for 480kHz SCS and 960kHz SCS, these consecutive slots within a search space period may be located outside the Y consecutive slots within a slot group, which may violet the definition of multi-slot PDCCH monitoring capability. Therefore, a new interpretation of *duration* should be defined. Considering the period in “*SearchSpace*” is defined as the integer multiple of X, it is straight forward to interpret the duration as the number of consecutive slot groups that a “*SearchSpace*” lasts in every period.  ***Proposal 5: The search space configuration should be enhanced to accommodate multi-slot PDCCH monitoring.***  In unlicensed band, it is beneficial to access the channel as soon as possible, when gNB passes the LBT. For this reason, the PDCCH monitoring occasion needs to occur frequently in the time domain. However, frequent monitoring of PDCCH consumes a plenty of power on the UE side, which is not beneficial for UE. In order to resolve this issue, a mechanism of search space set group switching is introduced to balance the channel access possibility from gNB side and the power consumption on PDCCH monitoring of UE side. For 480kHz SCS and 960KHz SCS, assuming X=2, the duration of a slot group is 62.5/31.25 us, which is similar to the length of two or one OFDM symbol for 30kHz SCS. Thus, sufficient flexibility in channel access can be ensured even with multi-slot PDCCH monitoring. In additional, supporting slot-based PDCCH monitoring means that additional slot-based PDCCH monitoring capability need to be defined, which requires additional standardization efforts. Therefore, it is not necessary to support search space set group switching between slot-based PDCCH monitoring and multi-slot based PDCCH monitoring. However, the balance between the channel access possibility and the power consumption on PDCCH monitoring is still needed. The periodicity of different search space set groups can be set differently, e.g. shorter periodicity can be set for out of COT period and longer periodicity can be set for in-COT period.  ***Proposal 6：It is not necessary to support search space set group switching between slot-based PDCCH monitoring and multi-slot PDCCH monitoring.***  ***Proposal 7:*** ***Search space set group switching between different search space set groups configured with different period should be supported.*** |

### R1-2111691 (NEC)

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| For operation in unlicensed band beyond 52.6GHz, in our understanding, the current SSSG switching can be reused for 120 kHz SCS, since it has been concluded: for 120 kHz SCS, no multi-slot UE capability for PDCCH monitoring is needed. So the monitoring capability before and after the switch is the same, both are per-slot based. While for 480 kHz and 960 kHz SCS, PDCCH monitoring capability may be changed along with SSSG switching, e.g. there are 2 configured SSSG, the first search space set defines PDCCH is monitored per 2-slots, and the second set defines PDCCH is monitored per 4-slots, the monitoring time unit and capability is different before and after the switching. If this scenario is supported, how to adapt it to R16 SSSG switching needs to be discussed.  **Proposal 3: For operation in unlicensed band with 480 kHz and 960 kHz SCS, consider whether/how to support SSSG switching along with changing different PDCCH monitoring capability.**  As mentioned in [5], in R16, the switching boundary is the first slot that is at least symbols after some switch indication and the timer decrement value is counted by slot. For 480 kHz and 960 kHz SCS, PDCCH monitoring capability is multi-slot based, e.g. 4 slots for 480 kHz SCS and 8 slots for 960 kHz SCS, the switching boundary and the timer counter should be modified to multi-slot based accordingly.  **Proposal 4: For operation in unlicensed band with 480 kHz and 960 kHz SCS, the switching boundary and the timer counter should be modified to slot group based.**  Currently,, which means the SSSG switching time, is defined for SCS configuration = 0,1,2. For new SCSs adopted beyond 52.6GHz, to operate in unlicensed band, SSSG switching time should be defined and added in the table 10.4-1 of TS 38.213[2].  **Proposal 5: Search space set group switching time should be defined for new SCSs.** |

### R1-2111708 (Panasonic)

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| From our point of view, in order to balance the UE complexity and network scheduling flexibility, UE should be able to support two spans of MOs per slot of Y, with each span having the maximum 3 symbols in duration. This allows network to transmit Group(1) SS and Group(2) SS at different symbols of a slot to the UE. The spans can be located in any symbol of a slot. The separation of the two spans is subject to UE capability. The candidate values could be 7 and 14 symbols, which is counted from the beginnings of the two spans following the convention in Rel-16.  **Proposal 2: In case of multi-slot monitoring, UE should support two spans of MOs per slot of Y. Each span has duration up to 3 OFDM symbols. The separation of the two spans is subject to UE capability.** |

### R1-2111726 (Samsung)

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| To support multi-slot PDCCH monitoring, a UE would expect that a time gap between any two consecutive PDCCH monitoring spans is not smaller than X, while any PDCCH monitoring duration is up to Y slots. PDCCH monitoring occasions are determined according to configured search space sets, where PDCCH monitoring periodicity and duration are configured in a number of slots for a search space set *s*, wherein those parameters should be enhanced to be compatible with the multi-slot PDCCH monitoring capability.    Figure 1 illustrates an example of multi-slot PDCCH monitoring with combination of (X = 4, Y =2), wherein the configuration of search space set 3 is invalid because the duration for consecutive PDCCH monitoring occasions from search space sets is not smaller than Y. In general, the PDCCH monitoring periodicity should not be smaller than X, i.e. , while the PDCCH monitoring duration is not larger than Y, i.e. . Moreover, in order to maintain the repeated pattern of Y slots within X-slot group, the PDCCH monitoring periodicity should be further restricted to the value as integer multiple of X, i.e. , wherein is a positive integer.    **Figure 1: Illustration of search space set configurations limited by combination of (X = 4, Y =2).**  **Proposal 4: For multi-slot PDCCH monitoring based on combination (X, Y), the PDCCH monitoring periodicity is , , and the PDCCH monitoring duration is .**  Another aspect impacted by multi-slot PDCCH monitoring is the determination of CCE locations for a PDCCH candidate. The determination of CCE indexes for a PDCCH candidate is based on a parameter, , where is the slot index of the PDCCH monitoring occasion. For multi-slot PDCCH monitoring, the index of the first slot from the X-slot group should be used to determine , i.e. is replaced by *,* for each PDCCH monitoring occasion within the X-slot group; otherwise, with updated per slot and considering the time-first mapping for PDCCH and that Y can be more than 1 slot, the Rel-16 CCE-based structure for PDCCH transmissions cannot be maintained.  **Proposal 6: For multi-slot PDCCH monitoring, is replaced by for determining the CCE location.**  For 60 GHz unlicensed band, transmissions are expected to be highly directional. To address the channel access efficiency, a transmitter can choose an intended beam direction to perform the channel access procedure, and the sensed result is exclusively applicable to that intended beam direction only. Hence, indicating COT, available RB set, and search space group switching should be associated with the beam direction, wherein such feature was introduced in Rel-16 NR-U by using DCI format 2\_0 and in a cell-specific manner. Generalizing the feature to a beam-specific manner is beneficial to address different interference situations along beam directions, and is compatible with the intention to introduce directional LBT.  **Proposal 7: Support indicating COT, available RB set, and search space group switching in a beam-specific manner for 60 GHz licensed band.** |

### R1-2111862 (Apple)

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| Search Space Set Group Switching was introduced in Rel-16 NR-U for power saving. It operates on CSS Type 3 and USS and allows the UE to switch between two groups of search space sets to either increase or decrease the UE search space set monitoring to save power as needed e.g. within and outside a COT in unlicensed access.  With the introduction of the new SCSs, there may be a need to modify timeline parameters such as the searchSpaceSwitchDelay and searchSpaceSwitchTimer. This may be set in units of slots or multi-slots based on the UE capability and the SCS.  In Rel-16, the switching boundary and the timer decrement value are on the order of slots. In the case of MSM PDCCH monitoring, as the PDCCH may be on the order of multiple slots, both the switching boundary and the timer decrements can be modified to be on the order of multi-slots as needed. The effect of MSM on the transition boundary and the time unit of multiple slots (4 slot) is illustrated in Figure 1.  *A picture containing chart  Description automatically generated*  Figure 1: Example of SSSG switching with multi-slot monitoring limitations  ***Proposal 8:*** *Consider the effect of the change in SCS and of MSS PDCCH monitoring on SSSG switching.* |

### R1-2112012 (Sharp)

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| At the last meeting, several options were proposed for monitoring of Group (1) and Group (2) SS (Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS. Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS). Each Option has its own advantages and disadvantages, but considering the time spent on the Back-to-Back problem, it is important to avoid this problem. Also, since the time left for discussion is limited, it is necessary to adopt the option that has the less impact on the specification.  The biggest problem with monitoring for Group(1) and Group(2) SS is that Type0 CSS is required to monitor two consecutive slots, n0 and n0+1. Option B-rev1 assumes monitoring of Group(2) SS outside the Y-slot, but there is a possibility that a back-to-back problem will occur with a period of about 20ms. Therefore, we propose to reduce the probability of the back-to-back problem by setting the UE not to monitor the Type 0 CSS in the CONNECTED state. For these reasons, Option B-rev1 with modifications to the Group(2) SS monitoring should be supported.  **Figure 1: Back-to-back problem with Type0 CSS monitoring in CONNECTED mode.**  **Proposal 7: Option B-rev1 should be supported. On top of that, a potential solution to avoid back-to-back problem is that UE does not monitor Type 0 CSS when in CONNECTED mode.**  The search space for single-slot monitoring of 15~120 kHz SCS is specified by the parameter "*monitoringSlotPeriodicityAndOffset*", "*duration*" and "*monitoringSymbolsWithinSlot*". However, since multi-slot monitoring at 480 kHz and 960 kHz basically monitors every multiple of X slots, such as 4 or 8, there are many periods that cannot be specified by the value of these parameters. Therefore, it is necessary to create an alternative parameter or revise parameter which matches the multi-slot monitoring.  **Figure 2: SearchSpace parameters that need to be rebuilt or revised.**  **Proposal 8: Search Space should be modified to match multi-slot monitoring**  SSSG switching was originally introduced for Rel-16 NR-U. The motivation was to enable dynamic switching between frequent PDCCH monitoring (e.g., out of COT) and infrequent PDCCH monitoring (e.g., within COT) that may consume less UE power. The benefit of reducing power consumption by dynamic SSSG switching is even significant for higher SCSs of 480 kHz and 960 kHz where slots are shorter, in addition to the original motivation for NR-U. Therefore, SSSG switching should also be used for 480kHz/960kHz SCS.  In FR2-2 operation, since the PDCCH monitoring capability is on a multi-slot basis at 480 kHz/960 kHz SCS, the processing load may locally exceed the capability of the UE during SSSG switching. In other words, there is a potential back-to-back problem when performing SSSG switching with multi-slot monitoring.  **Proposal 9: We support SSSG switching with enhancements for 120kHz/480kHz/960kHz SCS.**  **Observation 3: Potential back-to-back problem during SSSG switching in multi-slot monitoring should be investigated.** |

### R1-2112030 (Convida Wireless)

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| ***Proposal 1.*** All SS sets (i.e., Group (1) SS and Group (2) SS) are within the same Y consecutive slots to avoid back-to-back monitoring issue.  In some scenario, UE may not need to monitor SS every slot group. Hence, we prefer some SS periodicity in Group (1) SS can be integer multiple of slot group X. In other words, a UE can be configured with monitoring periodicity to be integer multiple of slot group X and its monitoring occasion locates within YGroup1 for Group (1) SS.  ***Proposal 2.*** *For 52.6GHz and above, it is preferred that the SS periodicity for Group (1) SS can be integer multiple of slot group X****.*** |

### R1-2112046 (LG)

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| **Proposal #2: In order to ensure the flexible location of the Y consecutive slots within a slot-group to be determined based on slot n0, one of the followings should be supported.**   * + **Alt 1: Type-0 PDCCH monitoring should be enhanced such as monitoring in slot n0 and slot n0+X**   + **Alt 2: Consecutive Y slots should be defined in a wrap-around manner within a slot-group of X slots if any enhancement for Type-0 PDCCH monitoring is not supported**   RRC (re)configuration may be the simplest method for shifting the location of Y slots within a slot-group according to the change of n0. But, if it takes too much time to change the location of Y through RRC (re)configuration, a method through MAC-CE or DCI indication can also be considered. In this case, after the n0 change is triggered, the application delay should be considered from triggering n0 change to applying the change of Y location. After the UE recognizes that slot n0 associated with the best SSB is changed (or after the UE is configured/indicated with changed location of Y slots), the related processing time for UE or gNB may be required. Regardless of whether such change of Y location is UE-initiated or gNB-initiated event, the application delay for both UE and gNB may be useful. In this case, it should be specified how much application delay is required to change the location of Y slots within a slot-group.  **Proposal #3: For the operation of shifting the location of Y consecutive slots within a slot-group, at least RRC (re)configuration should be supported. On top of RRC (re)configuration, MAC-CE or DCI can be considered to indicate the updated location of Y consecutive slots. When the MAC-CE or DCI indication is applied to this operation, the application delay should be specified.**  SS set configuration can also be set appropriately for the slot-group. Through SS set configuration based on slot-group, PDCCH monitoring occasion could be adjusted properly (e.g., restricted), and then, additional power saving effects would be expected. For slot-group based PDCCH monitoring, specifically, *periodicity* could be configured to a multiple of X slots. Furthermore, considering that the location of Y slots in a slot-group may be changed, *offset* may be defined in relation to the time-offset of the Y slot location due to n0. That is, *offset* could be a function of the time-offset when the location of Y slots within a slot-group of X slots is changed according to the location of slot n0 which is associated SSB index. For example, multiple candidate values for *offset* can be configured for a SS set configuration and each value can be linked to the candidate of the possible time-offset due to n0 change. If the location of Y slots in the slot-group is shifted, then *offset* parameter for the SS set configuration is set to the value corresponding to the shifted time-offset.  **Proposal #6: Consider to configure PDCCH monitoring occasions to be compliant with the slot-group and the time-offset due to the change of the slot index n0 such that *periodicity* is a multiple of X and *offset* depends on the time-offset or the location of the slot n0.**  Regarding SSSG switching, in Rel-15/16 NR, one SSSG could be switched to another SSSG at the slot boundary after at least P\_switch symbols from the switching triggering. However, if SSSG switching is introduced for multi-slot monitoring in Rel-17, SSSG switching should be performed at the slot-group boundary in order to be compliant with the slot-group. In addition, it may be necessary to discuss the appropriate P\_switch values for 480 kHz and 960 kHz.  **Proposal #7: For 480 kHz or 960 kHz multi-slot monitoring, SSSG switching should be performed at the slot-group boundary, if supported.** |

### R1-2112097 (NTT DOCOMO)

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| In the current specification, the SSSG switching time is specified for 15/30/60 kHz SCS. To support the SSSG switching, at least should be discussed for 120/480/960 kHz SCS. More specifically, should be specified for UE processing capability 1 since UE processing capability 2 is not likely to be supported according to the discussion on AI 8.2.4 and 8.2.5. The scaled value based on the one with 60 kHz SCS such as the ones shown in below table can be baseline, i.e., larger than such values should be avoided.  Table 1: Minimum SSSG switching time for UE processing capability1   |  |  | | --- | --- | |  | Minimum value for UE processing capability 1 [symbol] | | 0 | 25 | | 1 | 25 | | 2 | 25 | | 3 | 50 | | 5 | 200 | | 6 | 400 |   In addition, some companies proposed at the previous meeting that single-slot PDCCH monitoring capability and multi-slot PDCCH monitoring capability can be switched associated with SSSG configuration. This function can be supported, however, the SSSG switching for high SCS and single-slot and multi-slot capability switching associated with SSSG configuration should be discussed separately.  **Proposal 8: SSSG switching time for UE processing capability1should be specified for 120/480/960 kHz SCS.**   * **Scaling based on the one with 60 kHz SCS can be baseline (i.e. larger than such values should be avoided)** |

### R1-2112204 (Qualcomm)

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| |  | | --- | | * FFS: Search space configuration   + For Group (1) SS     - A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots     - The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots     - The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)     - BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots |   The suggested scheme above implies that the location of YGroup1 in a slot group changes in a semi-dynamic manner based on the value of . The value of shall be determined in association with an SSB as per Rel-15. That is, the SSB associated with is determined by the most recent of   * A MAC CE activation command indicating a TCI state for the CORESET associated with the CSS (i.e., CORESET #0), where the TCI-state includes a CSI-RS that is quasi-co-located with the SSB, or * A recent random access procedure by the UE, which is not initiated by a PDCCH order.   Although the suggested scheme may achieve the intended goals of retaining Rel-15 SS set #0 and aligning MOs of USS and CSS, it introduces many new issues, which render the benefit of the scheme over the original Options A and B unclear. For example, to allow the semi-dynamic change of Group (1) occasions, the existing offset configuration of a SS set should be invalidated, and the entire procedure of determining PDCCH MOs should be re-designed. Also, from network’s perspective, the semi-dynamic changes of Group (1) occasions will make multiplexing and scheduling of UEs more complicated. Hence, in our view, continuing the discussion based on the original Option A and Option B is preferred.  Proposal 4: Introducing an offset for Group (1) based on slot index , which may change in a semi-dynamic manner, is not considered for multi-slot PDCCH monitoring.  Observation 2: Monitoring two consecutive slots for Group (2) SS sets within a slot group introduces lots of challenges in the UE implementation.  Observation 3: With the legacy SS set #0 design, the numbers of BD/CCEs assigned for Group (2) SS sets within a group of X slots can be very large and the remaining BD/CCE for Group (1) would be limited.  Observation 4: Even when Group (1) and Group (2) SS sets do not share common Y consecutive slots within a slot group of X slots, the legacy SS set #0 may not be applicable.  Proposal 5: For 480 kHz and 960 kHz SCSs with multi-slot PDCCH monitoring, SS set #0 (i.e., Group (2) SS sets) of SSB-CORESET multiplexing pattern 1 should be re-designed: for a slot index , UE monitors SS set #0 in   * **Alt 1) slot and slot , where for 480 kHz and for 960 kHz,** * **Alt 2) slot only.**   **A prioritization rule for Group (1) or Group (2) SS sets**  Assume a value of YTotal, where (YGroup1+YGroup2) ≥ YTotal ≥ YGroup1 ≥ YGroup2. If the number of slots configured with at least one of Group (1) and Group (2) SS sets (i.e., up to YGroup1+YGroup2 slots) is larger than YTotal, one of the Groups is dropped in its entirety. After dropping is applied, the number of remaining slots for PDCCH monitoring within a slot group is guaranteed to be less than or equal to YTotal. Based on the principle of CSS prioritization in Rel-15, the conditions of dropping can be as follows:   * If Group (2) includes Type1 CSS w/o dedicated RRC configuration, Group (2) is prioritized and Group (1) is dropped. * If Group (1) includes Type1 CSS with dedicated RRC configuration and the UE is expecting to receive a DCI format in the Type1 CSS (i.e., within a RAR window), Group (1) is prioritized and Group (2) is dropped. Otherwise, Group (2) is prioritized.   In Figure 1, an example of the aforementioned rule is illustrated for (YGroup1, YGroup2, YTotal) = (1 slot, 1 slot, 1 slot). In Figure 1 (a) and (b), since the number of slot(s) for PDCCH monitoring does not exceed YTotal = 1 slot, no dropping is necessary. However, in Figure 1 (b), Group (1) and Group (2) are overlapped, and the CSS prioritization as per Rel-15 should be applied within the overlapped slot. That is, when a CSS MO overlaps with a USS MO with a different QCL-TypeD property, monitoring of the CSS MO is prioritized. In Figure 1 (c), Group (1) and Group (2) do not overlap, and the total number of slots for PDCCH monitoring exceeds YTotal = 1 slot. Hence, Group (2) is prioritized, and Group (1) is dropped.  During the connected mode operation, monitoring of Group (2) SS sets is relatively infrequent (e.g., once every 20 ms) and thus the actual dropping event of PDCCH transmission in Group (1) SS sets would be rare. Also, even though the Group (1) SS sets are dropped by the aforementioned prioritization rule, the UE can still receive a scheduling grant with C-RNTI within the CSS MOs in Group (2) via DCI format 0\_0/1\_0. Therefore, the impact of the proposed prioritization rule can be kept marginal.  Proposal 6: The maximum total number of slots for PDCCH monitoring in a slot group, YTotal, is restricted per UE capability.   * **(YGroup1+YGroup2) ≥ YTotal ≥ YGroup1 ≥ YGroup2** * **If the total number of slots configured with at least one of Group (1) and Group (2) SS sets exceeds YTotal, a rule for dropping some of the slots can be applied.** * **Ex) (YGroup1, YGroup2, YTotal) = (1 slot, 1 slot, 1 slot) as the mandatory capability.**     (a)    (b)    (c)  Figure 1: Prioritization of Group (2) SS sets over Group (1) SS sets. |

## Topic A3: BD Budget/Dropping

### R1-2110828 (Huawei, HiSilicon)

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| **Maximum number of monitored PDCCH candidates per slot(s) for a DL BWP with SCS configuration for a single serving cell. for, for . otherwise.**   |  |  | | --- | --- | |  | **Maximum number of monitored PDCCH candidates per slot(s) and per serving cell** | | 0 | 44 | | 1 | 36 | | 2 | 22 | | 3 | 20 | | 5 | 20 | | 6 | 20 |   **Table 4. Maximum number of non-overlapped CCEs per slot(s) for a DL BWP with SCS configuration for a single serving cell. for, for . otherwise.**   |  |  | | --- | --- | |  | **Maximum number of non-overlapped CCEs per slot(s) and per serving cell** | | 0 | 56 | | 1 | 56 | | 2 | 48 | | 3 | 32 | | 5 | 32 | | 6 | 32 |  1. ***The BD and CCE budgets for multi-slot PDCCH monitoring are defined per X-slot group. The maximum number of PDCCH candidates and non-overlapped CCEs per X slots for 480 kHz and 960 kHz SCSs is the same as for 120 kHz SCS with slot-level PDCCH monitoring.*** 2. ***For UE with multi-slot PDCCH monitoring capability, NB should ensure the number of monitored PDCCH candidates and non-overlapped CCEs for configured CSS sets and all search spaces on secondary cell not exceeding the maximum number per X slots.*** 3. ***All PDCCH candidates for UE-SS k with k>=j across the Y slots will be dropped if the number of monitored PDCCH candidates and non-overlapped CCE exceeds the maximum numbers per X-slot after SS j is added (assuming that the BD/CCE budget is checked in order of increasing SS index (as in in Rel-15)) but doesn’t exceed the budget before SS j is added.*** |

### R1-2110873 (Futurewei)

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| A gNB can configure the UE with several PDCCH candidates/CCEs per slot that exceeds the UE capability, which is referred to as overbooking. As specified in TS 38.213 “A UE does not expect to be configured CSS sets that result to corresponding total, or per scheduled cell, numbers of monitored PDCCH candidates and non-overlapped CCEs per slot or per span that exceed the corresponding maximum numbers per slot or per span, respectively.” In Rel 15 the monitoring capability is defined per slot, in Rel 16 the monitoring capability per span is added, where the span length ls shorter than a slot. The monitoring capability is defined by *monitoringCapabilityConfig* for a serving cell.  For multi-slot PDCCH monitoring it is expected that UE maps the PDCCH candidates using the Y span, where the span may be larger than one slot. Reusing the existing approach for overbooking rules is a natural choice. In the last RAN1-106bis e-meeting, most companies supported the dropping of the entire slot group when the BD/CCE capability is exceeded. In other words, a UE drops UE specific search space set(s) with higher index when SS sets are overbooked and expects there is no overbooking for CSS sets. In addition, if USS set is configured across multiple slots in a slot group, USS set should be checked and dropped as a whole.  **Proposal 5: Reuse the Rel-15/16 overbooking rules with extension to slot group dropping when PDCCH candidates/CCEs exceeds either of the UE processing limits per span.**  The following FL proposal in the RAN1-106bis captured the majority support. Therefore, we propose to adopt it as an agreement.  **Proposal 6: The following limits apply for multi-slot monitoring within X slots**   * **The maximum number of monitored PDCCH candidates per X = 4 slots for a DL BWP with 480 kHz SCS configuration for a single serving cell is 20.** * **The maximum number of monitored PDCCH candidates per X = 8 slots for a DL BWP with 960 kHz SCS configuration for a single serving cell is 20.** * **The maximum number of non-overlapped CCEs per X = 4 slots for a DL BWP with 480 kHz SCS configuration for a single serving cell is 32.** * **The maximum number of non-overlapped CCEs per X = 8 slots for a DL BWP with 960 kHz SCS configuration for a single serving cell is 32.** |

### R1-2110999 (vivo)

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| The following alternatives are the candidate method to determine the value of :   * Alt. 1: =X\*, X\*, where per slot limit and should be defined first; * Alt. 2: Use the value in 120K as the reference, = and = * Alt. 3: Determine each value for supported (X, Y) using the following table:  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | Maximum number of non-overlapped CCEs per slot group for combination and per serving cell | | | | | |  | (4, 1) | (4, 2) | (8, 1) | (8, 2) | (8, 4) | | 5 |  |  |  |  |  | | 6 |  |  |  |  |  |   Among the above alternatives, Alt. 3 is a similar way with that for span-based capability, which clearly provides the BD/CCE budget value as well as supported (X, Y) value.  **Proposal 5: For NR Rel-17 UEs, supported (X, Y) value should be determined first and then decide corresponding BD/CCE budget value for each (X, Y) case by case.**  In NR operation from 52.6-71GHz, BD/CCE budget will be defined for multiple slot as agreed. In this case, PDCCH candidates should be allocated for multiple slots in overbooking case. In existing NR operation, PDCCH candidates are allocated per slot in granularity of SS. However, in multi-slot-based PDCCH monitoring capability case, PDCCH candidates could be allocated to multiple slots in granularity of SS and slot. How to allocate the PDCCH candidates in two dimensions should be considered.  **Proposal 7: In multi-slot-based PDCCH monitoring capability case, PDCCH candidates could be allocated to multiple slots in granularity of SS and slot.** |

### R1-2111075 (ZTE, Sanechips)

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| **Proposal 4: There is a strong need to consider BD/CCE budget for per slot PDCCH monitoring for SCS 480 kHz and 960 kHz, recommended value range are shown in Table 1.**  **Table 1: Maximum number  of monitored PDCCH candidates and non-overlapped CCEs per slot for a DL BWP with SCS configuration  for a single serving cell**   |  |  |  | | --- | --- | --- | |  | **Maximum number of monitored PDCCH candidates per slot and per serving cell** | **Maximum number of non-overlapped CCEs per slot and per serving cell** | | **0** | **44** | **56** | | **1** | **36** | **56** | | **2** | **22** | **48** | | **3** | **20** | **32** | | **5** | **[15-20]** | **[24-32]** | | **6** | **[10-15]** | **[16-24]** |   Regarding USS set dropping in multi-slot PDCCH monitoring, same as in Rel-15, a USS set with higher SS set index is dropped. There are two alternative options when the USS set is configured in multiple slots,  Alt1: The USS set in multiple slots with higher SS set index is dropped slot by slot when overbooking happens.  Alt2: The whole USS set in multiple slots with higher SS set index is dropped when overbooking happens.  Considering configuration and standardization complexity, we slightly prefer Alt 2 even though Alt1 can save more slots of USS.  **Proposal 7: For multi-slot PDCCH monitoring capability, the similar dropping rule as Rel-15 can be used.**   * **The SS set dropping rule is only allowed for PCell or PSCell** * **The gNB should guarantee that the configured CSS sets do not exceed a UE’s capability** * **The whole USS set in multiple slots with higher SS set index is dropped when overbooking happens.** |

### R1-2111092 (Spreadtrum)

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| |  | | --- | | TS 38.213 [2]:  A UE does not expect to be configured CSS sets that result to corresponding total, or per scheduled cell, numbers of monitored PDCCH candidates and non-overlapped CCEs per slot or per span that exceed the corresponding maximum numbers per slot or per span, respectively.  For same cell scheduling or for cross-carrier scheduling, a UE does not expect a number of PDCCH candidates, and a number of corresponding non-overlapped CCEs per slot or per span on a secondary cell to be larger than the corresponding numbers that the UE is capable of monitoring on the secondary cell per slot or per span, respectively. If a UE is provided monitoringCapabilityConfig-r16 = r16monitoringcapability for the primary cell, except the first span of each slot, the UE does not expect a number of PDCCH candidates and a number of corresponding non-overlapped CCEs per span on the primary cell to be larger than the corresponding numbers that the UE is capable of monitoring on the primary cell per span. |   The similar rules could be extended to multi-slot span. For PCell or PSCell, it is allowed that the numbers of monitored PDCCH candidates and non-overlapped CCEs in a multi-slot span by the configuration of SS set(s) that exceed the corresponding maximum numbers. Define certain dropping rules, so that the actual number in the multi-slots span does not exceed the corresponding maximum number.  ***Proposal 1: PDCCH overbooking per-slot in NR Rel-15 can reused in multi-slot for beyond 52.6GHz.***  In Rel-15, there is no dropping method applied to the CSS set for PCell/PSCell. Therefore, the similar rule can be reused in multi-slot spans. When handling USS sets, if the total number of BDs/CCEs exceeds the corresponding maximum number, the same principle as Rel-15 can be reused,namely dropping USS sets with high index of SS sets.  ***Proposal 2: It is expected that there is no dropping for CSS sets for PCell/PSCell in PDCCH overbooking.***  ***Proposal 3: For USS sets, the same dropping principle as Rel-15 can be reused as baseline.*** |

### R1-2111196 (Nokia, Nokia Shanghai Bell)

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| When considering numerical values for the maximum number of PDCCH candidates and the maximum number of non-overlapping CCEs, we think that the existing capabilities defined for 120 kHz SCS could be used as the (min) UE capability, i.e.   * 20 PDCCH candidates per 120 kHz SCS slot duration * 32 non-overlapped CCEs per 120 kHz SCS slot duration.   Based on that, (20 BDs, 32 CCEs) should be supported in at least the most relaxed multi-slot PDCCH scenarios:   * (X, YGroup1,YGroup2) = (8,1,2), (8,2,2), (4,1,2)   For other multi-slot PDCCH scenarios [(X, YGroup1,YGroup2) = (8,4,2), (4,2,2), (2,1,2)], we are open to consider reduced values, e.g. [10 BDs, 16 CCEs].  ***Proposal 7****: For the cases with (X, YGroup1,YGroup2) = (8,2,2), (8,1,2), (4,1,2)*   * *support 20 PDCCH candidates per max(YGroup1,YGroup2)* * *support 32 non-overlapped CCEs per max(YGroup1,YGroup2).*   ***Proposal 8****: For the cases with (X, YGroup1,YGroup2) = (8,4,2), (4,2,2), (2,1,2)*   * *support [at least 10] PDCCH candidates per max(YGroup1,YGroup2)* * *support [at least 16] non-overlapped CCEs per max(YGroup1,YGroup2).* |

### R1-2111419 (Charter)

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| **Proposal 1b: Support SS dropping in case n0 changes.**  For general PDCCH monitoring with 480/960 kHz SCS, a simple extension of Rel-15/16 dropping rules is sufficient for BD budget compliance.  **Proposal 2: All PDCCH candidates for UE-SS k with k>=j across the Y slots will be dropped if the number of monitored PDCCH candidates and non-overlapped CCE exceeds the maximum numbers per X-slot after SS j is added (assuming that the BD/CCE budget is checked in order of increasing SS index (as in in Rel-15)) but doesn’t exceed the budget before SS j is added.** |

### R1-2111464 (Ericsson)

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| In NR Rel-15 specs, the network ensures the number of monitored PDCCH candidates and the number of non-overlapped CCEs for configured CSS sets per slot do not exceed the UE capabilities per slot. PDCCH monitoring overbooking is not supported for an SCell:  A UE does not expect to be configured CSS sets that result to corresponding total, or per scheduled cell, numbers of monitored PDCCH candidates and non-overlapped CCEs per slot that exceed the corresponding maximum numbers per slot.  For same cell scheduling or for cross-carrier scheduling where a scheduling cell and scheduled cell(s) have DL BWPs with same SCS configuration , a UE does not expect a number of PDCCH candidates, and a number of corresponding non-overlapped CCEs per slot on a secondary cell to be larger than the corresponding numbers that the UE is capable of monitoring on the secondary cell per slot.  For multi-slot PDCCH monitoring with 480/960 kHz SCS, both principles should be applied.   1. For multi-slot PDCCH monitoring with 480/960 kHz SCS, the network ensures:    1. the number of monitored PDCCH candidates and the number of non-overlapped CCEs for configured CSS sets within a slot group for a PCell/PSCell do not exceed the UE capabilities per slot group; and    2. PDCCH monitoring overbooking is not supported for an SCell.   In NR Rel-15 specs, the UE first allocates the monitoring occasions of configured CSS sets in a slot. The monitoring occasions of a USS set , starting with the lowest USS set index, in a slot are allocated for monitoring by the UE only if   * The addition of the number of PDCCH candidates in USS set does not cause UE BD capability to be exceeded; and * The addition of the additional number of non-overlapping CCEs for monitoring USS set considering the already allocated PDCCH candidates for monitoring does not cause UE CCE capability to be exceeded.   Once a USS set is found to trigger against either of the above UE capability limits, the UE terminates the monitoring occasion allocation procedure. Consequently, all USS sets with index are not monitored by the UE.  For multi-slot PDCCH monitoring with 480/960 kHz SCS, the same principles should be applied.   1. For multi-slot PDCCH monitoring with 480/960 kHz SCS on a PCell/PScell, the UE first allocates the monitoring occasions of all configured CSS sets in a slot group.    1. The monitoring occasions of a USS set , starting with the lowest USS set index, in a slot group are allocated for monitoring by the UE only if (1) the addition of the number of PDCCH candidates in USS set , and (2) the addition of the additional number of non-overlapping CCEs for monitoring USS set considering the already allocated PDCCH candidates for monitoring do not cause UE BD/CCE capabilities per slot group to be exceeded.    2. Once a USS set is found to trigger against either of the above UE capability limits per slot group, the UE terminates the monitoring occasion allocation procedure. Consequently, all monitoring occasions of all USS sets with index for the slot group are not monitored by the UE.   As in Rel-15/16 procedure, this monitoring occasion allocation for a slot group is to be performed for each slot group independently (of the preceding or subsequent slot group).  With Rel-17 work approaching closing, RAN1 should strive to progress in the multi-slot PDCCH processing capabilities for 480/960 kHz SCS. Toward this end, we propose to adopt the second approach for Rel-17 multi-slot PDCCH processing capabilities for 480/960 kHz SCS.   1. RAN1 agrees to the following multi-slot PDCCH processing capability values for 480/960 kHz SCS to progress the Rel-17 specification effort:    1. 480 kHz SCS with X=4: and .    2. 960 kHz SCS with X=8: and . |

### R1-2111484 (Intel)

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| In NR Rel-15, according to the UE capability on the maximum number of BDs/CCEs in a slot,   * For PCell or PSCell, it is allowed that the configured number of BDs/CCEs in a slot by the configuration of SS set(s) is larger than the corresponding maximum numbers. Certain dropping rule is defined so that the actual number in the slot doesn’t exceed the corresponding maximum numbers. * For a SCell, the gNB should guarantee that the configured numbers of BDs/CCEs in a slot by the configuration of SS set(s) do not exceed the corresponding maximum numbers.   The similar rules could be extended to multi-slot PDCCH monitoring capability,   * For PCell or PSCell, it is allowed that the configured number of BDs/CCEs in a X-slot group by the configuration of SS set(s) is larger than the corresponding maximum numbers. Certain dropping rule is defined so that the actual number in the X-slot group doesn’t exceed the corresponding maximum numbers. * For a SCell, the gNB should guarantee that the configured numbers of BDs/CCEs in a X-slot group by the configuration of SS set(s) do not exceed the corresponding maximum numbers.   **Proposal 7:**   * When multi-slot PDCCH monitoring capability is supported,   + PDCCH overbooking is supported for PCell or PSCell   + For a SCell, the configured BDs/CCEs do not exceed the corresponding maximum numbers.   As in Rel-15, it is desired there is no dropping for CSS sets even for PCell/PSCell. Therefore, it is up to gNB to guarantee that CSS sets are properly configured. One thing to note is that multiple slots in a X-slot group may contain MOs for a CSS set subject to gNB configuration. In this case, the total numbers of BDs/CCEs in the multiple slots for the CSS set are multiple times of that configured in single slot. Consequently, the numbers of available BDs/CCEs for USS sets are reduced. The UE capability on maximum numbers of BDs/CCEs needs to consider the increase of BDs/CCEs in the X-slot group for a CSS set.  Regarding handling USS sets if total number of BDs/CCEs exceed the corresponding maximum numbers, a same principle as in Rel-15 can be reused, i.e., a USS set with high SS set index is dropped. Further, since the PDCCH MOs of the USS set may be configured in multiple slots in the X-slot group, a discussion point is whether the USS set in all the multiple slots is dropped as a whole or dropped slot by slot. The latter option is preferred since it allows more capacity for PDCCH monitoring without exceeding UE capability.  **Proposal 8:**   * To handling USS dropping in PDCCH overbooking   + A USS set with largest SS set index is dropped   + If the PDCCH MOs of a USS set are configured in multiple slots in the X slots, the USS set in the multiple slots is dropped slot by slot. |

### R1-2111642 (Lenovo, Motorola Mobility)

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| ***Observation 1: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, when multi-slot PDCCH monitoring is applied with shifting of Group(1) SS due to n0 change, then potential back-to-back monitoring issue can arise across slot groups where the shift is applied***  ***Observation 2: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, when multi-slot PDCCH monitoring is applied with shifting of Group(2) SS due to n0 change, then potential back-to-back monitoring issue can arise across slot groups where the shift is applied, and periodicity of Group(s) SS MOs is every slot group***  One potential solution could be to drop any Group(1) SS MOs and/or Group(2) SS MOs in the slot group in which shifting needs to be applied such that back-to-back monitoring issue can be avoided. Therefore, in above example, there will be no Group(1) SS MO in slot group 2. The shifted MO for Group(1) SS can be applied from slot group 3, as shown in Figure 2 below.  ***Proposal 2: For supporting NR between 52.6 GHz and 71 GHz with high subcarrier spacing values including 480kHz and 960kHz, then dropping of Group(1) SS MOs and/or Group(2) SS MOs in the slot where the shift is first applied should be supported***    **Figure 2: Example of dropping first Group(1) SS MO (assuming no shifting) to avoid back-to-back monitoring when n0 changes** |

### R1-2111673 (Transsion Holdings)

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| The BD/CCE budget is closely related to the values of X in multi-slot PDCCH monitoring. When the value of X can be 4 or 8 for 480kHz SCS or 960kHz SCS respectively, the duration of one slot group is equal to that of one slot with 120kHz SCS. In order to maintain the same PDCCH monitoring complexity as in 120kHz SCS, the same maximum number of monitored PDCCH candidates and non-overlapped CCEs can be applied to multi-slot PDCCH monitoring. Regarding X=2 for 480kHz SCS or X=4 for 960kHz SCS, the maximum number of monitored PDCCH candidates and non-overlapped CCEs can be scaled down to half.  **Table 1. Maximum number of monitored PDCCH candidates per X slots for a DL BWP with SCS configuration  for a single serving cell.**   |  |  |  |  | | --- | --- | --- | --- | |  | **Maximum number of monitored PDCCH candidates per X slots and per serving cell** | | | | **X=2** | **X=4** | **X=8** | | 5 | 10 | 20 | - | | 6 | - | 10 | 20 |   **Table 2. Maximum number of non-overlapped CCEs per X slots for a DL BWP with SCS configuration  for a single serving cell.**   |  |  |  |  | | --- | --- | --- | --- | |  | **Maximum number of non-overlapped CCEs per X slots and per serving cell** | | | | **X=2** | **X=4** | **X=8** | | 5 | 16 | 32 | - | | 6 | - | 16 | 32 |   ***Proposal 1: Additional values of X could be 2 for 480kHz SCS and 4 for 960kHz SCS respectively for multi-slot PDCCH monitoring.*** |

### R1-2111708 (Panasonic)

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| In Rel-15/16, gNB is allowed to configure UE with UE-specific search spaces (USS) exceeding the BD/CCE limits that UE is capable of processing, which is referred to as overbooking. When allocating PDCCH candidates for monitoring, the USS with higher set index can be dropped in order to respect the UE capability. The overbooking with dropping rules facilitate gNB to use UE capability to its maximum. Otherwise, the configuration of MOs would be restricted to the worst case, resulting in resource under-utilization for typical cases.  The existing dropping rules for overbooking are applicable for individual slot or individual span within one slot. In the context of multi-slot monitoring capability, there is a need to extend the dropping rules for overbooking to across-slots or across-spans. In particular, for a X-slot group, gNB is allowed to configure USS in a way that the sum of all configured CSSs and USSs exceed UE multi-slot capability in terms of BD/CCE limits, and/or maximum number of spans, and/or minimum time separation between two spans. This is referred to overbooking for multi-slot capability. When UE and gNB map the PDCCH candidates to monitoring occasions, CSS are mapping first before USS (no overbooking for CSS, as the legacy). USSs are then mapped considering the BD/CCE requirements, the maximum allowed number of spans, and the minimum time separation between the two spans jointly. For example, when USSs are mapped in ascending order of the USS indices, if a USS MO cannot satisfy the minimum time separation from already mapped spans of MOs, the USS will be dropped. The details of enhancement can be further discussed when the multi-slot capability definition as discussed in previous two sections is finalized.  **Proposal 3: Dropping rules for overbooking need to be extended to across-slots or across-spans for multi-slot monitoring capability.**   * **For a X-slot group, gNB is allowed to configure USS in a way that the sum of all configured CSSs and USSs exceed UE multi-slot capability in terms of BD/CCE limits, and/or maximum number of spans, and/or minimum time separation between two spans.** * **When UE and gNB map the PDCCH candidates to monitoring occasions, CSS are mapping first before USS (no overbooking for CSS, as the legacy). USSs are then mapped in ascending order if all of the following conditions is met, otherwise the concerned USS is dropped from the X-slot group:**   + **the BD/CCE budget**   + **the maximum allowed number of spans**   + **the minimum time separation between the two spans** |

### R1-2111726 (Samsung)

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| The limits for PDCCH candidates/non-overlapping CCEs at high SCS can be defined per X-slot group depending on PDCCH monitoring capabilities. For multi-slot PDCCH monitoring, the limits for PDCCH candidates and non-overlapping CCEs can be defined per combination of (X, Y), similar to multi-symbol span based PDCCH monitoring in NR Rel-16. If X is much larger than Y, e.g. X ≥ 2Y, UE should have sufficient time to process the PDCCH decoding located within the Y slots, and in such case, Y may not be essential for determining the values of and , and only X can contribute to determining the values. One simple way of determining such values is reusing the corresponding values for slot based PDCCH monitoring in 120 kHz SCS.  **Proposal 3: Support maximum number of PDCCH candidates, and maximum number of non-overlapped CCEs, per X-slot group for each combination (X, Y).**  In Rel-16, a procedure to resolve overbooking conditions for PDCCH monitoring per slot or span in a slot is specified in TS 38.213. For a search space set, when a resulting total number of monitored PDCCH candidates or non-overlapped CCEs would exceed corresponding maximum values in a slot or span, the UE will drop PDCCH monitoring for the search space set and for remaining search space sets with higher indexes.  For multi-slot PDCCH monitoring as illustrated in Figure 2, the PDCCH candidate dropping rule should be extended to support PDCCH monitoring in a X-slot group. For example, the time-domain unit of one slot for performing the dropping rule should be extended to a X-slot group, while keeping other details the same as in current specification. Given a multi-slot PDCCH monitoring capability of , and , a UE should allocates , or to CSS sets first regardless of the location within the X-slot group, and then allocate the remaining PDCCH candidates or non-overlapping CCEs to USS sets in the order of search space set index. In the example illustrated in Figure 2, the PDCCH candidates/non-overlapping CCEs allocation order for the configured search space sets are: CSS, USS set #1, USS set #2.    **Figure 2: Allocation of PDCCH candidates with combination (X = 4, Y =2).**  Moreover, when a UE is configured with CA operation, the PDCCH candidate dropping rule per multi-slot should be extended to multiple CCs that are configured with multi-slot PDCCH monitoring capability. For a UE configured with CA operation, NR Rel-16 supports multiple PDCCH monitoring capabilities, such that gNB can configure some cells with Rel-15 per slot based PDCCH monitoring capability, and some other cells with Rel-16 per span based PDCCH monitoring capability. The same principle can be reused to include multi-slot PDCCH monitoring capability as another candidate for PDCCH monitoring capability configuration.  **Proposal 5: Support PDCCH candidate dropping per a X-slot group for a single serving cell and across multiple CCs in CA.** |

### R1-2112012 (Sharp)

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| For 120 kHz SCS, the BD/CCE budget is set to (M, C) = (20, 32). Since the value of X is determined to maintain the same monitoring capability as 120 kHz SCS, the BD/CCE budget should be (M, C) = (20, 32) for X=4/8 at 480kHz/960kHz SCS. If a smaller X value is set as an optional capability, the BD/CCE budget will be reduced because the gap between Y slots becomes shorter. Even though the symbol length is shorter than 120 kHz, ensuring the same budget may affect the processing time of PDSCH/PUSCH (N1/N2).  **Proposal 6: For X=4/8 at 480kHz/960kHz SCS, the BD/CCE budget should be set to (M, C) = (20, 32).**  **Observation 1: If a smaller X value is set as an optional capability, the BD/CCE budget will be reduced.**  **Observation 2: Ensuring the budget may affect the processing time of PDSCH/PUSCH (N1/N2).** |

### R1-2112046 (LG)

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| In the last meeting, there was a discussion about the BD/CCE limit for X=4/8 for 480/960 kHz SCS respectively. Many companies preferred to set the BD limit per X is 20 and CCE limit per X is 32 to align the multi-slot monitoring for 480/960 kHz SCS with the per-slot monitoring for 120 kHz SCS. We tend to agree that, at least for X=4/8 for 480/960 kHz SCS, the same BD/CCE limit as 120 kHz SCS can be defined per X. For other values of X, the BD/CCE limit can be further discussed.  **Proposal #5: BD/CCE budget for 480/960 kHz SCS could be defined per X slot-group for a DL BWP for a serving cell. That is,**   * + **The maximum number of monitored PDCCH candidates per X=4/8 slots for a DL BWP with 480/960 kHz SCS configuration for a single serving cell is 20.**   + **The maximum number of non-overlapped CCEs per X=4/8 slots for a DL BWP with 480/960 kHz SCS configuration for a single serving cell is 32.** |

### R1-2112097 (NTT DOCOMO)

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| At RAN1#106-e meeting, it was agreed that X=4/8 slots are supported for 480/960 kHz SCS for multi-slot PDCCH monitoring capability. The duration of 4/8 slots for 480/960 kHz SCS are same as that of 1 slot for 120 kHz SCS. Thus, the same maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot for 120 kHz SCS as below table 10.1-2 and 10.1-3 should be supported per 4/8 slots for 480/960 kHz SCS, i.e., the maximum number of monitored PDCCH candidates per 4/8/ slots for 480/960 kHz SCS should be 20 and the maximum number of non-overlapped CCEs per 4/8/ slots for 480/960 kHz SCS should be 32.  **Proposal 4: For defining the multi-slot PDCCH monitoring capability for 480 and 960 kHz SCS,**   * **the maximum number of monitored PDCCH candidates per X slots and per serving cell should be 20 when X=4/8 for 480/960 kHz SCS respectively.** * **the maximum number of non-overlapped CCEs per X slots and per serving cell should be 32 when X=4/8 for 480/960 kHz SCS respectively.**   In addition to the support of X=4/8 slots for 480/960 kHz SCS, it was agreed to support X=[2/]4 slots for [480/]960 kHz SCS as optional. Hence it is necessary to specify BD/CCE budget for X=[2/]4 slots for [480/]960 kHz SCS, but there is no reference value for the same absolute time duration. According to the trend for existing values for lower SCSs in the current specification shown in below table 10.1-2 and 10.1-3, it seems not just scaled based on absolute time duration. Furthermore, X=[2/]4 slots for [480/]960 kHz SCS are supported as optional UE capability, so it should be larger than the scaled value from X=4/8 slots for 480/960 kHz SCS. Therefore, we think larger than the scaled values should be considered for X=[2/]4 with [480/]960 kHz.  **Proposal 5: BD/CCE budget for X=[2/]4 slots for [480/]960 kHz SCS should be specified and larger than** **the scaled values from existing values should be considered.**  In Rel-15/16, the SS set can be overbooked per NW configuration, and the SS set dropping rule is defined per slot/span to deal with the situation when the BD/CCE exceed their budget from UE perspective. More specifically, PDCCH candidates or non-overlapped CCEs can exceed BD/CCE limit only for USS in PCell and PSCell to allow NW to configure proper SS set locations considering all the UEs in the cells. These PDCCH overbooking rules can be reused for multi-slot PDCCH monitoring capability, i.e., for USS in PCell and PSCell, PDCCH overbooking should be allowed.  When SS set overbooking happens as a result, a UE drops search space set(s) with higher index to ensure actual PDCCH candidates or non-overlapped CCEs to be no more than their budget per slot in Rel-15/16. To extend it considering multi-slot PDCCH monitoring capability, at least the rule for the case when a SS set is configured across multiple slots in a slot group needs to be discussed. If SS set(s) is checked and dropped slot by slot, how many SS set(s) is dropped may be divergent per slot, which will cause more UE complexity and specification effort in our view. Therefore, the USS set in multiple slots should be checked and dropped per slot group.  **Proposal 6: The SS set overbooking can be allowed with multi-slot PDCCH monitoring capability same as the current specification, i.e., SS set overbooking is allowed for USS in PCell and PSCell and UE expects no overbooking for CSS and CSS/USS in SCell.**  **Proposal 7: The dropping rule for multi-slot PDCCH monitoring capability can be the same as the current specification, i.e., a UE drops UE specific search space set(s) with higher index when SS sets are overbooked and expects there is no overbooking for CSS sets. In addition, if USS set is configured across multiple slots in a slot group, USS set should be checked and dropped as a whole.** |

### R1-2112204 (Qualcomm)

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| The numbers in the proposal above are the same as those for the per-slot PDCCH monitoring capability for 120 kHz SCS. The intention of the proposal is to achieve at least the same extent of scheduling flexibility, complexity, and power consumption as the 120 kHz SCS. Without deeper investigation on the feasible scaling rule, which should be very time consuming, relying on the exiting capability would be a good starting point. Hence, it seems fair to confirm the above proposal.  Proposal 1: For the multi-slot PDCCH monitoring capability with X = 4 for 480 kHz SCS and X = 8 for 960 kHz SCS, at least the same maximum numbers of PDCCH candidates and non-overlapped CCEs as 120 kHz SCS are supported (i.e., 20 BDs and 32 CCEs).  **A prioritization rule for Group (1) or Group (2) SS sets**  Assume a value of YTotal, where (YGroup1+YGroup2) ≥ YTotal ≥ YGroup1 ≥ YGroup2. If the number of slots configured with at least one of Group (1) and Group (2) SS sets (i.e., up to YGroup1+YGroup2 slots) is larger than YTotal, one of the Groups is dropped in its entirety. After dropping is applied, the number of remaining slots for PDCCH monitoring within a slot group is guaranteed to be less than or equal to YTotal. Based on the principle of CSS prioritization in Rel-15, the conditions of dropping can be as follows:   * If Group (2) includes Type1 CSS w/o dedicated RRC configuration, Group (2) is prioritized and Group (1) is dropped. * If Group (1) includes Type1 CSS with dedicated RRC configuration and the UE is expecting to receive a DCI format in the Type1 CSS (i.e., within a RAR window), Group (1) is prioritized and Group (2) is dropped. Otherwise, Group (2) is prioritized.   In Figure 1, an example of the aforementioned rule is illustrated for (YGroup1, YGroup2, YTotal) = (1 slot, 1 slot, 1 slot). In Figure 1 (a) and (b), since the number of slot(s) for PDCCH monitoring does not exceed YTotal = 1 slot, no dropping is necessary. However, in Figure 1 (b), Group (1) and Group (2) are overlapped, and the CSS prioritization as per Rel-15 should be applied within the overlapped slot. That is, when a CSS MO overlaps with a USS MO with a different QCL-TypeD property, monitoring of the CSS MO is prioritized. In Figure 1 (c), Group (1) and Group (2) do not overlap, and the total number of slots for PDCCH monitoring exceeds YTotal = 1 slot. Hence, Group (2) is prioritized, and Group (1) is dropped.  During the connected mode operation, monitoring of Group (2) SS sets is relatively infrequent (e.g., once every 20 ms) and thus the actual dropping event of PDCCH transmission in Group (1) SS sets would be rare. Also, even though the Group (1) SS sets are dropped by the aforementioned prioritization rule, the UE can still receive a scheduling grant with C-RNTI within the CSS MOs in Group (2) via DCI format 0\_0/1\_0. Therefore, the impact of the proposed prioritization rule can be kept marginal.  Proposal 6: The maximum total number of slots for PDCCH monitoring in a slot group, YTotal, is restricted per UE capability.   * **(YGroup1+YGroup2) ≥ YTotal ≥ YGroup1 ≥ YGroup2** * **If the total number of slots configured with at least one of Group (1) and Group (2) SS sets exceeds YTotal, a rule for dropping some of the slots can be applied.** * **Ex) (YGroup1, YGroup2, YTotal) = (1 slot, 1 slot, 1 slot) as the mandatory capability.**     (a)    (b)    (c)  Figure 1: Prioritization of Group (2) SS sets over Group (1) SS sets. |

## Topic B: Multi-Beam Aspects

### R1-2110873 (Futurewei)

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| In 60 GHz bands due to higher pathloss corresponding to high frequency it is expected that the transmitters use directional beams. In TS 38.213 Clause 10.1, the *ControlResourceSet* variables are defined. The antenna port quasi co-location is provided by *TCI-State* indicating the quasi co-location of the DM-RS antenna port for PDCCH reception in the respective CORESET.If the UE is not provided with a configuration of TCI state(s)the UE assumes that the DM-RS antenna port associated with PDCCH receptions is quasi co-located with SS/PBCH the UE identified during the initial access procedure.  **Proposal 8: Use the existing mechanism for beam configuration and activation for multi-slot PDCCH monitoring.** |

### R1-2111196 (Nokia, Nokia Shanghai Bell)

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| One more issue related to DL control seems to be operation of DCI format 2\_0 in a beam based system. In Rel. 15, DCI format 2\_0 contained only SFI, and from SFI point of view, UL and DL direction is clearly beam agnostic due to strong self-coupling between different panels. On the other hand, in R16 DCI format 2\_0 contains also other information, such as COT or SS-group switching trigger, RB-sets. Any of these pieces of information could become beam dependent. However, support for beam-dependent configurations of DCI format 2\_0 is not possible in FR2 currently. Although a UE can be indicated a change of active-TCI, DCI format 2\_0 PDCCH candidates and, payload location remains the same and thus cannot be beam specific.    ***Observation 2:*** *GC-PDCCH is an essential part of unlicensed band system, and there seems to be a need to support beam-dependent information, particularly if some form of directional LBT is chosen as coexistence mechanism.*  In addition, for 480kHz and 960kHz SCS, the beam agnostic SFI becomes lengthy and thus leads to increased configuration overheads. Moreover, for 5ms COT and 960kHz the SFI may become as long as 320 slots that exceeds the legacy format limit of 256 slots, so SFI cannot be made with a single DCI 2\_0 message in the beginning of the COT with current FR2 signalling. Hence, support for improved SFI format in DCI 2\_0 is desired.  ***Proposal 9:****Changes to DCI format 2\_0 may be beneficial for at least unlicensed 60GHz NR operation.* |

### R1-2111242 (CATT)

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| In Rel-16, the DCI format 2\_0 is used for indicating the slot format, COT duration, available RB set and search space group switching to a group of UEs. The UEs within the group should monitor the Type-3 PDCCH CSS on the indicated beam direction according to the TCI state of the associated CORESET. There are proposals to enhance DCI format 2\_0 to indicate COT duration, available RB set and search space group switching in a beam specific manner. In our opinion, the beam management related enhancement of DCI format 2\_0 can be further studied in the Rel-18 to ensure a unified solution with all other related issues.  ***Proposal 5：The enhancement of DCI format 2\_0 can be further studied in the Rel-18 to ensure a unified solution with all beam management issues.*** |

### R1-2111386 (Sony)

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| As haven been mentioned by multiple companies in previous meetings [3]-[7]: In Rel-16 NR-U, several fields such as CO duration, SS-group switching trigger, RB-sets, etc., were introduced to DCI format 2\_0. In the frequency range above 52.6 GHz, that information can be beam-dependent due to the utilization of beamforming. Therefore, there is a need to consider per beam indication of DCI format 2\_0.  **Proposal 4: Support per beam indication of DCI format 2\_0 for above 52 GHz unlicensed operation.** |

### R1-211642 (Lenovo, Motorola Mobility)

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| Another important aspect for PDCCH monitoring is related to directional LBT. Directional LBT may cause some issues in comparison with omni-directional LBT. For example, different Tx beams used by gNB may correspond to different COTs, thus different CORESETs which are configured with different Tx beams by higher layer signaling may also correspond to different COTs. From power saving perspective, according to the indicated sensing beam(s) used by the gNB to initiate a COT, a UE can stop monitoring the PDCCH occasions in the CORESET corresponding to a different Tx beam which is not ‘covered’ by the indicated sensing beam(s) until the current COT ends, which can reduce the power consumption cause by blind decoding. After transmitting a PDCCH to a UE within a COT, the gNB will not transmit PDCCH to this UE in the CORESET corresponding to another COT until the current COT ends.  ***Proposal 6: For NR unlicensed bands between 52.6 GHz and 71 GHz with directional LBT based channel access mechanism, within a COT, PDCCH monitoring is not supported in the CORESETs corresponding to other COTs (PDCCH monitoring restricted to monitoring corresponding to only one COT at a time)*** |

### R1-2111726 (Samsung)

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| For 60 GHz unlicensed band, transmissions are expected to be highly directional. To address the channel access efficiency, a transmitter can choose an intended beam direction to perform the channel access procedure, and the sensed result is exclusively applicable to that intended beam direction only. Hence, indicating COT, available RB set, and search space group switching should be associated with the beam direction, wherein such feature was introduced in Rel-16 NR-U by using DCI format 2\_0 and in a cell-specific manner. Generalizing the feature to a beam-specific manner is beneficial to address different interference situations along beam directions, and is compatible with the intention to introduce directional LBT.  **Proposal 10: Support indicating COT, available RB set, and search space group switching in a beam-specific manner for 60 GHz licensed band.** |

### R1-2111862 (Apple)

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| In R16 NR-U, DCI format 2-0 is enhanced to carry channel access related information: RB allocation, COT duration and search space set switching indication. While RB allocation information may not be needed depending on LBT bandwidth discussion, the COT duration and SSSG switching should be supported.  COT duration and SSSG switching information should be sent at the beginning of the COT as shown in Fig.1. However, current design of DCI format 2-0 transmission limit to one beam per slot. Therefore, it takes multiple slots to finish the beam sweeping transmission of DCI format 2-0. For example, with 120KHz SCS and 32 beams, it takes 4ms to finish beam sweeping. Considering maximum COT duration is 5ms defined by EN 302 567, more efficient transmission scheme of DCI format 2-0 is needed.  ***Proposal 9:*** *Consider enhancement of DCI 2-0 transmission to signal COT duration and SS adaptation at the beginning of the COT.* |

### R1-2112046 (LG)

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| In Rel-16 NR-U, several fields such as RB set indicator, CO duration and SS set group switching trigger were introduced to DCI format 2\_0, in addition to SFI. However, for FR2-2 in Rel-17 where the use of directional beams may be essential, it can be worth considering the beam dependent GC-PDCCH configuration. In other words, it may be beneficial to give a spatial relation for a beam to which information of DCI format 2\_0 is applied. One simple conceivable method is to define some fields in DCI format 2\_0 separately for each beam. For example, RB set indicator and CO duration could be configured separately for each beam, but SFI could be configured as beam agnostic. Alternatively, a new field can be additionally introduced in DCI format 2\_0 to indicate the availability of each beam. In this method, UE receiving DCI format 2\_0 may determine the channel availability for each beam through a combination of the new field and existing fields (i.e., RB set indicator and CO duration).  **Proposal #8: Consider per beam indication of available RB set, CO duration, and/or SS set switching by using DCI format 2\_0.** |

## Topic C: Multi-Cell Operation, Cross-carrier scheduling

### R1-2110999 (vivo)

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| In multi-cell operation scenario, BD/CCE budget calculation becomes more complex by introducing such multi-slot-based BD/CCE budget definition, i.e. more additional cases as described in 2.1.3.  As one straightforward way, the BD/CCE budget calculation adopts the same way for NR Rel-16, i.e. serving cells with the same PDCCH monitoring type are grouped together for further handling. Particularly, the follows steps apply:   * Determination of : UE needs to report respective for different cases, i.e. Case 1-7 as described in 2.1.3. For the case with mixed capability, *L* values need to be reported where *L* is the number of capability types in that case (e.g. 3 in case 7); * Determination of total limit for each group of serving cells:   + If the group adopts slot-based or span-based capability, legacy way is used;   + If the group adopts multi-slot-based capability, further divide the cell group into different parts depending on SCS and/or value of X/Y. Then BD/CCE budget for the serving cells will follow one total limit. Note that there may have certain limits in the group or part of serving cells.   As another alternative, the serving cell with SCS µ and multi-slot-based capability can be transformed to an equivalent virtual serving cell with SCS µ’ and slot-based capability, e.g. e.g. cell A with 480KHz SCS and BD/CCE budget per 4 slots is equivalent to a virtual cell A’ with 120KHz and BD/CCE budget per slot.  **Proposal 6: For multi-cell operation, the following alternatives could be considered:**  **Alt. 1: Serving cells with the same PDCCH monitoring type including multi-slot-based capability are grouped together for further BD/CCE budget calculation;**  **Alt. 2: Transform the serving cell with multi-slot-based capability to equivalent serving cell with slot-based capability for further BD/CCE budget calculation.** |

### R1-2111075 (ZTE, Sanechips)

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| The cross-carrier scheduling here mainly refers to cross-carrier scheduling of a cell within 52.6-71GHz band from/to a cell within FR1/FR2. Although a cell within 52.6-71GHz band cross-carrier schedules other cells within FR1/FR2 is less likely, it should not be ruled out unless we find enough proof. In order to further reduce the scheduling complexity, we support the cross-carrier scheduling via adding some restrictions, |*μPDCCH* − *μPDSCH* | ≤ k. Moreover, according to the most recent RAN plenary (RAN#93-e) [5], the following FR1 + FR2-2 band combinations should be considered.   * + Specify gNB and UE RF core requirements for the band(s) in the above frequency range, including a limited set of example band combinations (see Note 1).     - For the case of FR2-2 DC or CA with an anchor in FR1 the following three example band combinations shall be considered:       * n79 + Nx       * n77 + Nx       * n41 + Nx     - where Nx is the 57-71 GHz band for unlicensed operation and the [66-71] GHz for licensed operation.     - RAN4 to further discuss the need for single or multiple bands relevant for FR2-2 licensed/unlicensed operation.   Note 1: The WI can be completed provided requirements for at least one band combination involving a new NR-U band is specified as long as it is in line with country-specific regulatory directives.  We can not rule out the case of a cell with low SCS (e.g. 15kHz) cross-carrier schedules other cells with high SCS (e.g. 480kHz) since the bands n79, n77, n41 are defined in FR1. The value of k should be no less than 4 to support cross carrier scheduling from FR2-2 to FR1.  **Proposal 8: Cross-carrier scheduling of a cell within 52.6-71 GHz band from/to a cell within FR1/FR2 is supported, at least for |*μPDCCH* − *μPDSCH* | ≤ k and k ≥ 4.**  Another problems related to cross-carrier scheduling are minimum PDSCH scheduling delay and minimum A-CSI- RS trigger delay. In Rel-15/16 NR, cross-carrier scheduling only supports four cases of PDCCH with u = 0, 1, 2 and 3, as given in Table 5.5-1 and Table 5.2.1.5.1a in TS 38.214. The 120kHz SCS in above 52.6GHz band can reuse the value of u = 3. But the values of *µPDCCH* with 480/960kHz SCS need to be determined. The same values of *µPDCCH* for minimum PDSCH scheduling delay and minimum A-CSI-RS trigger delay can be used for 480/960kHz SCS.  TS 38.214 Table 5.5-1: *Npdsch* as a function of the subcarrier spacing of the scheduling PDCCH   |  |  | | --- | --- | | ***µPDCCH*** | ***Npdsch* [symbols]** | | 0 | 4 | | 1 | 5 | | 2 | 10 | | 3 | 14 |   TS 38.214 Table 5.2.1.5.1a: *Ncsirs* as a function of the subcarrier spacing of the triggering PDCCH   |  |  | | --- | --- | | ***µPDCCH*** | ***Ncsirs* [symbols]** | | 0 | 4 | | 1 | 5 | | 2 | 10 | | 3 | [14] |   **Proposal 9: The values of *µPDCCH* with 480/960kHz SCS for minimum PDSCH scheduling delay and minimum A-CSI-RS trigger delay should be determined.** |

### R1-2111092 (Spreadtrum)

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| Cross-carrier scheduling is useful for NR. Therefore, it is expected that cross-carrier scheduling between serving cells using SCS 120/480/960kHz can be supported. In the CA case, due to different SCS, some cells are based on single-slot PDCCH monitoring, some ones are based on multi-slot PDCCH monitoring, and some are based on multi-slot PDCCH monitoring, even the number of slot in the multi-slot is not same in different cells. One discussion point is how to determine the number of monitored PDCCH candidates and non-overlapping CCE for different cells combine in the CA scenario. In addition, another point of discussion is carrier aggregation (CA) between cells with frequencies of 52.6-71GHz and FR2 or even FR1 cells. Such CA scenario could be supported, especially considering PCells below 52.6-71GHz are more appropriate for coverage/robustness.  In the last meeting, the limitation (i.e., |*μPDCCH* − *μPDSCH* | ≤ k) for cross-carrier scheduling was discussed, and the candidate values for k are 3 and 4. For us, k = 3 is preferred, since this value is benefit for the processing timeline and memory requirement.  ***Proposal 2: For cross-carrier scheduling, k=3 is preferred.*** |

### R1-2111242 (CATT)

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| In the RAN1#106-e, the maximum difference of SCS of cross-carrier scheduling, i.e, , has been discussed. In the Rel-16, the maximum difference of SCS is equal to 3. However, 480 kHz SCS and 960 kHz SCS have been supported for 52.6-71GHz. We believe the maximum difference of SCS of cross-carrier scheduling should be expanded to support of new SCS, and there is no motivation to limit the difference of SCS of cross-carrier scheduling.  ***Proposal 6：In order to better support cross-carrier scheduling of the new SCS, i.e. 480 kHz and 960 kHz, the difference of SCS of cross-carrier scheduling should not be limited.*** |

### R1-2111464 (Ericsson)

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| It has been discussed in RAN1 whether to impose a limitation on cross-carrier scheduling:  Cross-carrier scheduling of a cell within 52.6-71 GHz from/to a cell outside 52.6-71 GHz is supported, at least for |*μPDCCH* − *μPDSCH*| ≤ k.  In the most recent RAN plenary (RAN#93-e), the WID was updated with the following FR1 + FR2-2 band combinations:   * Specify gNB and UE RF core requirements for the band(s) in the above frequency range, including a limited set of example band combinations (see Note 1).   + For the case of FR2-2 DC or CA with an anchor in FR1 the following three example band combinations shall be considered:     - n79 + Nx     - n77 + Nx     - n41 + Nx   + where Nx is the 57-71 GHz band for unlicensed operation and the [66-71] GHz for licensed operation.   + RAN4 to further discuss the need for single or multiple bands relevant for FR2-2 licensed/unlicensed operation.   Given that bands n41, n78, and n79 in FR1 are defined in 38.101-1 for both 15 and 30 kHz, |μPDCCH − μPDSCH| for cross-carrier scheduling from FR1 to FR2-2 can take values as large as 5 and 6 for 480 and 960 kHz SCS, respectively. Hence, if k is limited to 3, then cross carrier scheduling from FR1 to FR2-2 would not be supported at all, which is contrary to the spirit of the WID. On the other hand, limiting to k = 4 would mean that cross-carrier scheduling would at least be supported from FR1 with 30 kHz SCS to FR2-2 with 480 kHz. Hence, we believe that k should be no less than 4, and k = 5 should not be precluded without strong contrary evidence.   1. From cross-carrier scheduling of a serving cell from another cell of different numerologies is supported at least for |*μPDCCH* − *μPDSCH*| ≤ 5. |

### R1-2111484 (Intel)

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| Cross-carrier scheduling is a quite useful feature for NR. Therefore, it is expected that cross-carrier scheduling between serving cells using SCS 120/480/960kHz can be supported. On the other hand, one more discussion point is the carrier aggregation (CA) between a cell in FR2-2 and a cell in FR2-1 or even FR1. From specification completeness point of view, such CA scenario could be supported, especially considering a PCell in lower frequency than 52.6-71GHz is more appropriate for coverage/robustness. As discussed in MR-DC in Rel-16, the minimum PDSCH scheduling delay and minimum A-CSI RS triggering offset applicable to SCS 480kHz and 960kHz should be discussed. On the other hand, if such kind of CA is supported and cross-carrier scheduling is considered, an extreme case could be that a slot with SCS 15kHz is used to schedule up to 64 slots with SCS 960kHz. Without a clear motivation, we prefer to avoid unnecessary optimization.  **Proposal 13:**   * Cross-carrier scheduling of cell in FR2-2 from/to a cell of FR1 and FR2-1 is allowed by specification   + The minimum PDSCH scheduling delay and the minimum A-CSI RS triggering offset applicable to SCS 480kHz and 960kHz needs to be discussed.   + Additional enhancements are deprioritized unless a clear motivation is identified. |

### R1-2111563 (Xiaomi)

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| In current spec, UE can report its cross carrier scheduling capability for DL/UL separately by one of { low-to-high, high-to-low, both}, which has no restriction on the SCS difference of the carrier pair(the scheduling/scheduled carriers). but with the introduction of SCS 480/960KHz in NR 52.6-71GHz, the SCS difference of the carrier pair would be too large for UE to handle, for example, with carrier pair=15/480KHz, a slot in PDCCH channel would cover 32 slots in PDSCH channel. suppose the PDCCH channel is 3 symbol length, and UE need 2 symbol(in PDCCH channel) to decode the PDCCH, then and UE has to buffer all the PDSCH information with length of 5\*32=160 symbol in PDSCH channel. this would be challenging for UE implementation. So some restriction on cross carrier scheduling would be desirable, for example, UE can report its capability for supported carrier pair like .  ***Proposal 5: Some restriction on cross carrier scheduling would be desirable, for example, UE can report its capability for supported carrier pair like*** ***.*** |

### R1-2111862 (Apple)

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| For cross carrier scheduling the following issues should be studied:   1. *RAN1 should modify the parameter Npdsch to account for the new SCSs:* The parameter *Npdsch,* i.e., the # of PDCCH symbols after the end of the PDCCH scheduling the PDSCH needs to be modified for the new SCSs. 2. *RAN1 should study the effect of a large differential between the SCSs of the carriers involved in the cross carrier scheduling procedure.* In a scenario with different numerologies between PDSCH and PUCCH, a large differential between the SCSs may result in a large gap between a transmitted PDSCH(s) and its corresponding PUCCH. In one simple example, assume that the transmission occurs such that the HARQ is on FR1 with the SCS set to 15 kHz which is equivalent to 32 480 kHz slots. A frame structure of DDDSU would require an aggregation of up to 96 slots. The maximum differential changes from 8 (120 kHz to 15 kHz) to 64 (960 kHz to 15 kHz). 3. *The maximum number of carriers that can be simultaneously scheduled from a single carrier should be defined as a UE capability.* This may be necessary given the possible increase in the bandwidth of the different transmissions, and the increase in data rate for the new SCSs.   ***Proposal 5****: RAN1 should modify the parameter Npdsch, i.e. the # of PDCCH symbols after the end of the PDCCH scheduling the PDSCH, to account for the new SCSs.*  ***Proposal 6:*** *RAN1 should study the effect of a large differential between the SCSs of the carriers involved in the cross-carrier scheduling procedure.*  ***Proposal 7:*** *for cross-carrier scheduling, the max number of CCs that can be scheduled from a single CC is reported as UE capability.* |

### R1-2112046 (LG)

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| As described above, the location of the Y slot in a slot-group may change according to the change of the best SSB index in the slot-group for the PCell. Considering multi-slot monitoring with multiple serving cells, aligning the monitoring occasions for PCell and SCell(s) may offer the sufficient sleep time to the UE. In other words, the change of the location of Y slots in SCell(s) may also be useful in terms of power saving of UE. In a specific way, the location change of the Y slots in SCell(s) can be triggered when it occurs in PCell, and then the location of Y slots within a slot-group can be determined by applying the same time-offset as that for PCell. Additionally, in order to support more flexibility, it may be possible to determine the time-offset for the SCell separately from the PCell.  **Proposal #9: When the location of the Y consecutive slots within a slot-group for the PCell is changed, shifting the location of the Y slots in the slot-group for the SCell may also be considered. Two different ways can be considered as below,**   * + **The time-offset of Y slots in a slot-group for SCell can be determined based on that for PCell.**   + **The time-offset of Y slots in a slot-group for SCell can be determined separately from that for PCell.**   **Proposal #10: If a UE is configured with DL cells greater than the number of BD capable cells, consider followings for BD/CCE budget calculation,**   * + **For a serving cell configured with mandatory X (i.e. X=4/8 for 480/960 kHz), BD/CCE budget is calculated by transforming the serving cell to the cell with 120 kHz SCS.**   + **For a serving cell configured with optional X (i.e. X=[2]/4 for 480/960 kHz), BD/CCE budget is calculated by grouping the serving cell with other cells having the same PDCCH monitoring type including multi-slot-based capability.** |

### R1-2112301 (MediaTek)

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| One essential discussion to complete the multi-slot PDCCH monitoring design is how to extend the framework to multi-cell operation and how to specify the BD/CCE limit for multi-cell operation. To extend the multi-slot PDCCH monitoring to multi-cell operation, it is necessary to discuss whether the fixed pattern of slot groups and the location of the Y slots within the X slots are the same across CCs with (X,Y) multi-slot PDCCH monitoring configuration. Based on the current agreement, all the CCs with (X,Y) multi-slot PDCCH monitoring configuration share the same pattern of slot groups in order to simplify the design. As for the location of the Y slots within a slot group of X slots, compared with the fixed location of the Y slots within a slot group across CCs, non-aligned locations of Y slots can provide potential scheduling flexibility with the cost of complicating the BD/CCE limit distribution when multi-cell operation is considered. For example, it is possible that the monitoring slots in a cell with (X,Y) multi-slot PDCCH monitoring configuration might be close to the monitoring slots in another cell with the same (X,Y) multi-slot PDCCH monitoring configuration, which is illustrated in Figure 1. In this example, both CCs follow (X=4,Y=1) multi-slot PDCCH monitoring configuration and the BD/CCE limit assigned to monitoring slots M1\_2 in CC#1 and M2\_1 in CC#2 need to acknowledge UE monitoring capability on monitoring the back to back slots. Therefore, to complete the design, the multi-cell monitoring capability need to be carefully discussed. On the other hand, the fixed location of the Y slots across CCs have benefit on BD/CCE limit determination for CA operation, which expedites BD/CCE budge assignment from gNB perspective and facilitates PDCCH candidate dropping determination at UE side. Furthermore, the aligned PDCCH monitoring pattern across CCs can further improve PDCCH monitoring power consumption compared with the non-aligned PDCCH monitoring pattern.  Proposal 2: For multi-cell operation, the location of the Y slots within a slot group of X slots is maintained across CCs associated with (X,Y) configuration.   * BD/CCE limit for multi-cell operation is defined within a slot group of X slots across all the CCs     Figure 1 Example of non-aligned monitoring pattern across CCs in Alt2  Regarding the candidate values of (X,Y), at least X=4 slots and X=8 are agreed to be supported for multi-slot PDCCH monitoring in 480 kHz and 960kHz, respectively. To facilitate the discussion, we suggest to prioritize the discussion of Y values for the cases of X=4 slots for 480kHz and X=8 for 960kHz and we suggest at least Y=1 should be supported to achieve UE power saving. For other values of (X,Y), if needed, we prefer to have an UE capability to address the trade-off between UE implementation complexity and gNB scheduling flexibility.  Proposal 3: To achieve UE power saving in multi-slot monitoring, at least (X=4 slots, Y=1 slot) and (X=8 slots, Y=1 slot) should be supported for multi-slot PDCCH monitoring in 480 kHz and 960kHz, respectively. For other pairs of (X,Y), if needed, optional UE capability should be introduced. |

## Topic D: Other

# List of submitted TDocs

The following TDocs have been used to compile above summary:

**R1-2110828 Enhancement on PDCCH monitoring Huawei, HiSilicon**

**R1-2110873 PDCCH monitoring enhancements for Beyond 52.6GHz FUTUREWEI**

**R1-2110999 Remaining issues on PDCCH monitoring enhancements for NR operation from 52.6GHz to 71GHz vivo**

**R1-2111075 Discussion on the PDCCH monitoring enhancements for 52.6 to 71GHz ZTE, Sanechips**

**R1-2111092 Discussion on the PDCCH monitoring enhancements for above 52.6GHz Spreadtrum Communications**

**R1-2111196 PDCCH monitoring enhancements Nokia, Nokia Shanghai Bell**

**R1-2111242 PDCCH monitoring enhancements for up to 71GHz operation CATT**

**R1-2111308 Discussion on PDCCH monitoring enhancement OPPO**

**R1-2111386 PDCCH enhancement for NR from 52.6GHz to 71GHz Sony**

**R1-2111419 PDCCH monitoring enhancements Charter Communications**

**R1-2111464 PDCCH Monitoring Enhancements Ericsson**

**R1-2111484 Discussion on PDCCH monitoring enhancements for extending NR up to 71 GHz Intel Corporation**

**R1-2111563 PDCCH monitoring enhancement for NR 52.6-71GHz Xiaomi**

**R1-2111642 PDCCH monitoring enhancements for NR from 52.6 GHz to 71GHz Lenovo, Motorola Mobility**

**R1-2111673 Discussion on PDCCH monitoring enhancements for above 52.6GHz Transsion Holdings**

**R1-2111691 Discussion on PDCCH monitoring enhancements supporting NR from 52.6GHz to 71 GHz NEC**

**R1-2111708 PDCCH monitoring for NR operation from 52.6 to 71 GHz Panasonic**

**R1-2111726 PDCCH monitoring enhancements for NR from 52.6 GHz to 71 GHz Samsung**

**R1-2111833 Discussions on PDCCH monitoring enhancements InterDigital, Inc.**

**R1-2111862 Discussion on PDCCH Enhancements Apple**

**R1-2112012 PDCCH monitoring enhancements Sharp**

**R1-2112030 PDCCH Monitoring enhancement for NR from 52.6 GHz to 71 GHz Convida Wireless**

**R1-2112046 PDCCH monitoring enhancements to support NR above 52.6 GHz LG Electronics**

**R1-2112097 PDCCH monitoring enhancements for NR from 52.6 to 71 GHz NTT DOCOMO, INC.**

**R1-2112204 PDCCH monitoring enhancements for NR in 52.6 to 71GHz band Qualcomm Incorporated**

**R1-2112301 PDCCH monitoring enhancement for 52.6-71 GHz NR operation MediaTek Inc.**