**3GPP TSG RAN WG1#110 R1-22xxxxx**

**Toulouse, France, August 22nd – 26th, 2022**

**Agenda Item: 8.2**

**Source: Moderator (Lenovo)**

**Title: Draft FL Summary for B52.6 GHz PDCCH monitoring enhancements**

**Document for: Discussion, Decision**

# Issues for PDCCH monitoring enhancements

**Table 1 – Identified issues for PDCCH monitoring enhancements**

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| **Issue#** | **Issue** | **References** | **FL initial assessment** | **Company inputs (if any)** |
| 8.2.2-1 | multi-slot PDCCH monitoring for for Group (2) SSs | [1] [11]+[12] | H | [E///] H  [QC] L – We don’t think the changes are critical. The agreement on the Group (2) SS sets in RAN1 #109-e was already captured in the UE feature 24-4 and 24-5. Thus, we think the text in the CR is redundant. Note that, for Rel-15, the restriction of MO for Type1 CSS w/o dedicated RRC and Type0/0A/2 CSS is also captured in FG 3-1, not in TS 38.213.  [Nokia] H |
| 8.2.2-2 | Correction of PDCCH monitoring as given by *monitoringSlotsWithinSlotGroup* | [13] | L (may not be necessary) | [E///] Agree with moderator assessment – doesn't seem necessary as the previous sentence already seems to capture the case when monitoringSlotsWithinSlotGroup is not provided.  [QC] Agree with the moderator’s assessment.  [Nokia] L Agree with the moderator’s assessment |
| 8.2.2-3 | default value for duration-r17 for 480/960 kHz SCS | [6] | H | [E///] H  [QC] Agree with the moderator’s assessment.  [Nokia] Agree with the moderator’s assessment |
| 8.2.2-4 | PDCCH multi-slot monitoring restriction for DCI format 2\_1 | [2] | H | [E/// ] L  As per previous agreement the UE monitors in at most Ys consecutive slots per group of slots, hence the proposed TP seems to place further restriction and we're not sure why.  [QC] We generally agree with moderator’s assessment, but the issue may involve many other related issues, which we think should be discussed jointly. For example.   * Currently, DL pre-emption indication is per-UE capability. But it is questionable wether pre-emption indication is needed for 480/960 kHz SCSs, considering that the slot length is already very short. * How to define the 14 resources for slot-group based PDCCH monitoring?   [Nokia] L - This does not seem necessary |
| 8.2.2-5 | multi-slot PDCCH monitoring in CA or NR-DC scenarios | [3] [4] [5] [9]+[10] | H | [E///] H  Question on the TP in [4]: We're not clear on the reason for the restriction to same Xs for all serving cells. While this seems okay if all cells have the same SCS, what happens in a mixed SCS case?  [QC] Agree with moderator’s assessment except [4]. We share the same view as Ericsson.  [Nokia]: H. The TP according to [4] (restricting Xs to be same for all serving cells) could be under a separate issue. We consider that aspect as L. |
| 8.2.2-6 | SSSG switching with multiple cells and different Xs | [7]+[8] | L | [E///] L  Not clear on the motivation.  [QC] H – the issue was discussed in RAN1 #108-e.  [Nokia] L |

# Details

## Issue 8.2.2-1: multi-slot PDCCH monitoring for for Group (2) SSs

Documents [1] [11] [12] identify a lack of specification text for Group (2) SSs, since prior agreements have not been fully captured. Additionally a fix of typo and additional description of *monitoringSlotsWithinSlotGroup* are suggested.

38.213 TP according to [1]:

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| 10.1 UE procedure for determining physical downlink control channel assignment <Unrelated part omitted>  For each DL BWP configured to a UE in a serving cell, the UE is provided by higher layers with search space sets where, for each search space set from the search space sets, the UE is provided the following by *SearchSpace*:  - a search space set index , , by *searchSpaceId*  - an association between the search space set and a CORESET by *controlResourceSetId* or by *controlResourceSetId-v1610*  - a PDCCH monitoring periodicity of slots and a PDCCH monitoring offset of slots, by *monitoringSlotPeriodicityAndOffset* or by *monitoringSlotPeriodicityAndOffset-r17*  - a PDCCH monitoring pattern within a slot, indicating first symbol(s) of the CORESET for PDCCH monitoring within each slot where the UE monitors PDCCH, by *monitoringSymbolsWithinSlot*  - a duration of indicating a number of slots that the search space set exists by *duration*, or a number of slots in consecutive groups of slots where the search space set can exist by *duration-r17*  - a bitmap, by *monitoringSlotsWithinSlotGroup*, that applies per group of slots and provides a PDCCH monitoring pattern indicating slots in a group of slots for PDCCH monitoring  - a size of the group of slots is same as a size of *monitoringSlotsWithinSlotGroup*  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in dedicated RRC signaling, or for a Type3-PDCCH CSS set, or for a USS set, the PDCCH monitoring pattern indicates only consecutive slots in the group of slots for PDCCH monitoring and, at least for one combination indicated by the UE as a capability, a number of the consecutive slots is not larger than  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in *SIB1*, the PDCCH monitoring pattern indicates only up to 1 slot in the group of slots for PDCCH monitoring  - for a Type0-PDCCH CSS set or for a Type0A-PDCCH CSS set, or for a Type2-PDCCH CSS set, the PDCCH monitoring pattern indicates slots in the group of slots for PDCCH monitoring, and the slots are not restricted to be consecutive, a number of those slots is not larger than the size of *monitoringSlotsWithinSlotGroup*  - a number of PDCCH candidates per CCE aggregation level by *aggregationLevel1*, *aggregationLevel2*, *aggregationLevel4*, *aggregationLevel8*, and *aggregationLevel16*, for CCE aggregation level 1, CCE aggregation level 2, CCE aggregation level 4, CCE aggregation level 8, and CCE aggregation level 16, respectively  - an indication that search space set is either a CSS set or a USS set by *searchSpaceType*  <Unrelated part omitted>  Denote by , , the number of counted PDCCH candidates for monitoring for CSS set and by , , the number of counted PDCCH candidates for monitoring for search space set . If a UE indicates *three-BDforSSsetLinking* and is provided for search space set , by *searchSpaceLinking*, a search space set with , set if and are CSS sets or set if and are USS sets.  For the CSS sets in , a UE monitors PDCCH candidates requiring a total of non-overlapping CCEs in a slot, or in group of slots for a corresponding combination , or in a span.  Denote by the set of non-overlapping CCEs for search space set and by ; the cardinality of where a UE determines the non-overlapping CCEs for search space set considering the allocated PDCCH candidates for monitoring for the CSS sets in and the allocated PDCCH candidates for monitoring for all search space sets , .  Set  Set  Set  <Unrelated part omitted> |

38.213 TP according to [11]:

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| 10.1 UE procedure for determining physical downlink control channel assignment  \*\*\* Unchanged text omitted \*\*\*  For each DL BWP configured to a UE in a serving cell, the UE is provided by higher layers with search space sets where, for each search space set from the search space sets, the UE is provided the following by *SearchSpace*:  - a search space set index , , by *searchSpaceId*  - an association between the search space set and a CORESET by *controlResourceSetId* or by *controlResourceSetId-v1610*  - a PDCCH monitoring periodicity of slots and a PDCCH monitoring offset of slots, by *monitoringSlotPeriodicityAndOffset* or by *monitoringSlotPeriodicityAndOffset-r17*  - a PDCCH monitoring pattern within a slot, indicating first symbol(s) of the CORESET for PDCCH monitoring within each slot where the UE monitors PDCCH, by *monitoringSymbolsWithinSlot*  - a duration of indicating a number of slots that the search space set exists by *duration*, or a number of slots in consecutive groups of slots where the search space set can exist by *duration-r17*  - a bitmap of length *L*, by *monitoringSlotsWithinSlotGroup*, that applies per group of slots and provides a PDCCH monitoring pattern indicating slots in a group of slots for PDCCH monitoring  - a size of the group of slots is same as a size of *monitoringSlotsWithinSlotGroup*  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in dedicated RRC signaling, or for a Type3-PDCCH CSS set, or for a USS set, the PDCCH monitoring pattern indicates only consecutive slots in the group of slots for PDCCH monitoring and, at least for one combination indicated by the UE as a capability, a number of the consecutive slots is not larger than  - for a Type0/0A/2-PDCCH CSS set, the PDCCH monitoring pattern can indicate consecutive or non-consecutive slots in the group of slots for PDCCH monitoring, and the number of slots can be up to *L*  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in *PDCCH-ConfigCommon*, the PDCCH monitoring pattern can indicate one slot in the group of slots for PDCCH monitoring\*\*\* Unchanged text omitted \*\*\* |

## Issue 8.2.2-2: Correction of PDCCH monitoring as given by *monitoringSlotsWithinSlotGroup*

Document [13] identies that a description on the determination of PDCCH monitoring occasion by the parameter of *monitoringSlotsWithinSlotGroup* for 480/960 kHz SCS is missing from clause 10.1 in TS38.213.

FL Note: This aspect is somewhat covered by the following existing text in 38.213, but it would be good to check opinions if that is sufficient.

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| For each DL BWP configured to a UE in a serving cell, the UE is provided by higher layers with search space sets where, for each search space set from the search space sets, the UE is provided the following by *SearchSpace*:  […]  a bitmap, by *monitoringSlotsWithinSlotGroup*, that applies per group of slots and provides a PDCCH monitoring pattern indicating slots in a group of slots for PDCCH monitoring  - a size of the group of slots is same as a size of *monitoringSlotsWithinSlotGroup*  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in dedicated RRC signaling, or for a Type3-PDCCH CSS set, or for a USS set, the PDCCH monitoring pattern indicates only consecutive slots in the group of slots for PDCCH monitoring and, at least for one combination indicated by the UE as a capability, a number of the consecutive slots is not larger than  […] |

38.213 TP according to [13]:

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| **10.1 UE procedure for determining physical downlink control channel assignment**  >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>> unchanged text omitted <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<  A UE determines a PDCCH monitoring occasion on an active DL BWP from the PDCCH monitoring periodicity, the PDCCH monitoring offset, and the PDCCH monitoring pattern within a slot. For search space set , the UE determines that PDCCH monitoring occasions exist in a slot with number [4, TS 38.211] in a frame with number  if ( +-). If *monitoringSlotsWithinSlotGroup* is provided, the slot is the first slot in a group of slots and PDCCH monitoring occasions exist in the group of slots. The UE monitors PDCCH candidates for search space set for consecutive slots, starting from slot , and does not monitor PDCCH candidates for search space set for the next  consecutive slots. The slot(s) to be monitored within the consecutive slots are configured by *monitoringSlotsWithinSlotGroup* if *monitoringSlotsWithinSlotGroup* is provided.  >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>> unchanged text omitted <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<< |

## Issue 8.2.2-3: default value for duration-r17 for 480/960 kHz SCS

Document [6] identies that no default value for duration-r17 has been implemented in any of the RAN1 or RAN2 specs, although RAN1#108e agreed that If *duration-r17* is absent, the UE assumes the duration in slots is equal to L.

**Proposal: Send an LS to RAN2 to request that the default value of *duration-r17* for 480/960 kHz SCS when it is absent be specified in 38.331.**

## Issue 8.2.2-4: default value for duration-r17 for 480/960 kHz SCS

Document [2] identies that the existing monitoring occasion restriction for DCI format 2\_1 in a slot needs to be extended to PDCCH multi-slot monitoring.

38.213 TP according to [2]:

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| 11.2 Interrupted transmission indication If a UE is provided *DownlinkPreemption*, the UE is configured with an INT-RNTI provided by *int-RNTI* for monitoring PDCCH conveying DCI format 2\_1 [5, TS 38.212]. The UE is additionally configured with  - a set of serving cells by *int-ConfigurationPerServingCell* that includes a set of serving cell indexes provided by corresponding *servingCellId* and a corresponding set of locations for fields in DCI format 2\_1 by *positionInDCI*  - an information payload size for DCI format 2\_1 by *dci-PayloadSize*  - an indication granularity for time-frequency resources by *timeFrequencySet*  If a UE detects a DCI format 2\_1 for a serving cell from the configured set of serving cells, the UE may assume that no transmission to the UE is present in PRBs and in symbols that are indicated by the DCI format 2\_1, from a set of PRBs and a set of symbols of the last monitoring period. The indication by the DCI format 2\_1 is not applicable to receptions of SS/PBCH blocks.  The set of PRBs is equal to the active DL BWP as defined in clause 12 and includes  PRBs.  If a UE detects a DCI format 2\_1 in a PDCCH reception in a slot, the set of symbols is the last  symbols prior to the first symbol of the PDCCH reception in the slot where is the PDCCH monitoring periodicity provided by the value of *monitoringSlotPeriodicityAndOffset,* as described in clause 10.1,  is the number of symbols per slot,  is the SCS configuration for a serving cell with mapping to a respective field in the DCI format 2\_1,  is the SCS configuration of the DL BWP where the UE receives the PDCCH with the DCI format 2\_1. If the UE is provided *tdd-UL-DL-ConfigurationCommon*, symbols indicated as uplink by *tdd-UL-DL-ConfigurationCommon* are excluded from the last symbols prior to the first symbol of the PDCCH reception in the slot. The resulting set of symbols includes a number of symbols that is denoted as .  The UE does not expect to be provided values of , , and  resulting to a value of  that is not an integer. The UE does not expect to be configured by *monitoringSymbolsWithinSlot* with more than one PDCCH monitoring occasion for DCI format 2\_1 in a slot or by *monitoringSlotsWithinSlotGroup* with more than one PDCCH monitoring occasion for DCI format 2\_1 in a group of slots.  A UE is provided the indication granularity for the set of PRBs and for the set of symbols by *timeFrequencySet*.  If the value of *timeFrequencySet* is 'set0', 14 bits from MSB of a field in DCI format 2\_1 have a one-to-one mapping with 14 groups of consecutive symbols from the set of symbols where each of the first  symbol groups includes  symbols, each of the last  symbol groups includes  symbols, a bit value of 0 indicates transmission to the UE in the corresponding symbol group and a bit value of 1 indicates no transmission to the UE in the corresponding symbol group. |

## Issue 8.2.2-5: multi-slot PDCCH monitoring in CA or NR-DC scenarios

Documents [3] [9] [10] suggest naming alignment of capability parameters.

38.213 TP according to [3]:

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| 10 UE procedure for receiving control information \*\*\* Unchanged text omitted \*\*\*  If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, or larger than one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, or larger than one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs the UE can monitor for downlink cells with *monitoringCapabilityConfig* = *r15monitoringcapability*, or for downlink cells with *monitoringCapabilityConfig* = *r16monitoringcapability*, or for downlink cells with *monitoringCapabilityConfig* = *r17monitoringcapability* when the UE is configured for carrier aggregation operation over more than three downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, at least one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability* and at least one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*. When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot or per span or per group of slots that corresponds to downlink cells or to downlink cells or to downlink cells, respectively, where  - is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA1*  - otherwise,  - if the UE reports only one combination of (*pdcch-BlindDetectionCA1*, *pdcch-BlindDetectionCA2*, *pdcch-BlindDetectionCA3*), is the value of *pdcch-BlindDetectionCA1*  - else, is the value of *pdcch-BlindDetectionCA1* from a combination of (*pdcch-BlindDetectionCA1*, *pdcch-BlindDetectionCA2, pdcch-BlindDetectionCA3*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*  - is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA2*  - otherwise,  - if the UE reports only one combination of (*pdcch-BlindDetectionCA1*, *pdcch-BlindDetectionCA2*, *pdcch-BlindDetectionCA3*), is the value of *pdcch-BlindDetectionCA2*  - else, is the value of *pdcch-BlindDetectionCA2* from a combination of (*pdcch-BlindDetectionCA1*, *pdcch-BlindDetectionCA2, pdcch-BlindDetectionCA3*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*  \*\*\* Unchanged text omitted \*\*\* |

38.213 TP according to [10]:

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| 10 UE procedure for receiving control information  \*\*\* Unchanged text omitted \*\*\*  When a UE is configured for NR-DC operation with a total of downlink cells on both the MCG and the SCG and the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE expects to be provided *pdcch-BlindDetection4* for the MCG and *pdcch-BlindDetection4* for the SCG with values that satisfy  - *pdcch-BlindDetection4* for the MCG + *pdcch-BlindDetection4* for the SCG <= *pdcch-BlindDetectionCA3*, if the UE reports *pdcch-BlindDetectionCA3*, or  - *pdcch-BlindDetection4* for the MCG + *pdcch-BlindDetection4* for the SCG <= , if the UE does not report *pdcch-BlindDetectionCA3*  When a UE is configured for NR-DC operation and the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE may indicate, through *pdcch-BlindDetectionMCG-UE3* and *pdcch-BlindDetectionSCG-UE3*, respective maximum values for *pdcch-BlindDetection* for the MCG and *pdcch-BlindDetection* for the SCG.  If the UE reports *pdcch-BlindDetectionCA3*,  - the value range of *pdcch-BlindDetectionMCG-UE3* or of *pdcch-BlindDetectionSCG-UE3* is [1, …, *pdcch-BlindDetectionCA3*-1], and  - *pdcch-BlindDetectionMCG-UE3* + *pdcch-BlindDetectionSCG-UE3* >= *pdcch-BlindDetectionCA3.*  Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* and the UE is configured on both the MCG and the SCG for NR-DC as indicated in *UE-NR-Capability*  - the value range of *pdcch-BlindDetectionMCG-UE3* or of *pdcch-BlindDetectionSCG-UE3* is [1, 2, 3], and  - *pdcch-BlindDetectionMCG-UE3* + *pdcch-BlindDetectionSCG-UE3* >= .  \*\*\* Unchanged text omitted \*\*\* |

Document [4] proposes to expect the same Xs value across multiple carriers in multi-slot based PDCCH monitoring.

38.213 TP according to [4]:

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| 10 UE procedure for receiving control information  =============================== Unchanged Text Omitted ===================================  For , if the UE indicates a capability to monitor PDCCH according to multiple combinations and a configuration of search space sets to the UE for PDCCH monitoring on a serving cell results to a separation of every two consecutive groups of slots that is not smaller than for more than one combinations , of the multiple combinations , the UE monitors PDCCH on the cell according to the combination , from the more than one combinations , that is associated with the largest maximum number of and defined in Table 10.1-2B and Table 10.1-3B. The UE expects to monitor PDCCH on the cells according to the same , if the UE is configured for carrier aggregation operation or NR-DC operation.  =============================== Unchanged Text Omitted =================================== |

Document [5] proposes to resolve minimum CA capability values:

* + Case 4: Capability on the number of CCs with Rel-17 monitoring capability only
    - Range of pdcch-BlindDetectionCA-R17: {~~[2 or~~ 4~~]~~, …, 16}
  + Case 5: Capability on the number of CCs with Rel-15 monitoring capability and Rel-17 monitoring capability on different serving cells
    - * Range of pdcch-BlindDetectionCA-R15 + pdcch-BlindDetectionCA-R17: {~~[3 or~~ 4~~]~~, …, 16}
  + Case 6: Capability on the number of CCs with Rel-16 monitoring capability and Rel-17 monitoring capability on different serving cells
    - * Range of pdcch-BlindDetectionCA-R16 + pdcch-BlindDetectionCA-R17: {~~[2 or~~ 3~~]~~, …, 16}
  + Case 7: Capability on the number of CCs with Rel-15 monitoring capability, Rel-16 monitoring capability and Rel-17 monitoring capability on different serving cells
    - * Range of pdcch-BlindDetectionCA-R15 + pdcch-BlindDetectionCA-R16 + pdcch-BlindDetectionCA-R17: {~~[3 or~~ 4~~]~~, …, 16}

## Issue 8.2.2-6: SSSG switching with multiple cells and different Xs

Documents [7] 8] suggests naming alignment (please refer to individual documents for details).

38.213 TP according to [7]:

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| 10.4 Search space set group switching and skipping of PDCCH monitoring \*\*\* Unchanged text is omitted \*\*\*  A UE determines a slot and a symbol in the slot to start or stop PDCCH monitoring according to search space sets for a serving cell that the UE is provided *searchSpaceGroupIdList* or, if *cellGroupsForSwitchList* is provided, for a set of serving cells, based on the largest if the SCS configuration among all configured DL BWPs in the set of serving cells equals to 6, otherwise, based on the smallest SCS configuration among all configured DL BWPs in the serving cell or in the set of serving cells and, if any, in the serving cell where the UE receives a PDCCH and detects a corresponding DCI format 2\_0 triggering the start or stop of PDCCH monitoring according to search space sets.  \*\*\* Unchanged text is omitted \*\*\* |

# References

Contributions related to PDCCH monitoring enhancements

[1] R1-2206081 Draft CR on multi-slot PDCCH monitoring for TS 38.213 ZTE, Sanechips

[2] R1-2206363 Corrections for PDCCH monitoring occasion for DCI format 2\_1 for the features extending NR operation to 71 GHz CATT

[3] R1-2206732 Correction on multi-slot PDCCH monitoring in CA scenario with mixed capability types vivo

[4] R1-2206791 Draft CR for multi-slot PDCCH monitoring in FR2-2 Samsung

[5] R1-2207021 On UE capability parameters for CA with per-slot group monitoring Nokia, Nokia Shanghai Bell

[6] R1-2207023 Discussion on default value of duration-r17 in FR2-2 LG Electronics

[7] R1-2207024 Draft CR for SSSG switching with multiple cells in FR2-2 LG Electronics

[8] R1-2207025 Discussion on SSSG switching with multiple cells in FR2-2 LG Electronics

[9] R1-2207464 Draft CR on UE capability name alignment Ericsson

[10] R1-2207465 Discussion on UE capability name alignment Ericsson

[11] R1-2207466 Draft CR on Group 2 search space configuration Ericsson

[12] R1-2207467 Discussion on Group 2 search space configuration Ericsson

[13] R1-2207519 Corrections on PDCCH monitoring enhancement for 52-71GHz spectrum Huawei, HiSilicon