# RAN1 #102-e:

**~~Agreement~~**

~~The following is agreed for evaluation of PDCCH~~

* ~~According to the evaluation scenario (e.g., at FR1 in urban macro / at FR1 in indoor hotspot / at FR2 in indoor hotspot), one of three Tables (Table A.3-1 ~ A.3-3) of 38.824 can be a baseline of EVM for Rel-17 FeMIMO item 2a.~~
  + ~~System bandwidth other than those mentioned in the Tables can be considered and reported by the companies.~~
* ~~In addition, the following table is used for EVM for Rel-17 FeMIMO item 2a (Common assumptions for PDCCH/PUCCH/PUSCH)~~

|  |  |
| --- | --- |
| **~~Parameters~~** | **~~Values~~** |
| ~~The number of TRPs~~ | ~~2~~ |
| ~~Channel model~~ | ~~TDL for FR1 (CDL for FR1 can be optionally used)~~  ~~CDL for FR2 (TDL for FR2 can be optionally used)~~ |
| ~~Path-loss modeling~~ | ~~{0,3,6} dB gap between TRPs~~ |
| ~~Blockage~~ | ~~Blockage model from Rel-16 (x dB power offset with probability p): Companies to report x and p, and other assumptions, if any.~~ |
| ~~Target BLER~~ | ~~[10^-3, 10^-4, 10^-5]: BLER values shown in plots should be based on enough number of samples, e.g., ~100/BLER samples~~ |

* ~~The following table is used for detailed assumptions for PDCCH~~

|  |  |
| --- | --- |
| **~~Parameters~~** | **~~Values~~** |
| ~~Baseline schemes~~ | ~~Option 1: Rel-15 PDCCH~~  ~~Option 2: Spec transparent SFN~~  ~~For FR1: Both options 1 and 2 can be considered~~  ~~For FR2: Option 1.~~ |
| ~~AL~~ | ~~8 as baseline. Companies are encouraged to simulate other AL’s additionally for different code rate regimes.~~ |
| ~~# of RBs/symbols~~ | ~~1 or 2 symbols. Companies to report # of RBs.~~ |
| ~~DCI payload~~ | ~~40+24(CRC)=64 as baseline. Other payload values are not precluded.~~ |
| ~~CCE-to-REG mapping~~ | ~~Both Interleaved and non-interleaved can be considered. Companies to report the assumptions including interleaverSize in the case of interleaved.~~ |
| ~~REG bundling size~~ | ~~6 and 2 as baseline.~~ |
| ~~Precoding assumptions~~ | ~~Precoding cycling, precoder granularity=REG bundle as baseline.~~  ~~Closed-loop precoding can be used optionally~~ |
| ~~Schemes~~ | ~~Details of the schemes used (including TDM,FDM, etc.) to be reported by companies.~~ |
| ~~Receiver assumption~~ | ~~Up to companies to report~~ |

**Agreement**

To enable a PDCCH transmission with two TCI states, study pros and cons of the following alternatives:

* ~~Alt 1: One CORESET with two active TCI states~~
* ~~Alt 2: One SS set associated with two different CORESETs~~
* Alt 3: Two SS sets associated with corresponding CORESETs
* At least the following aspects can be considered: multiplexing schemes (TDM / FDM/ SFN / combined schemes), BD/CCE limits, overbooking, CCE-REG mapping, PDCCH candidate CCEs (i.e. hashing function), CORESET / SS set configurations, and other procedural impacts.

**Agreement**

For non-SFN based mTRP PDCCH reliability enhancements, study the following options:

* ~~Option 1 (no repetition): One encoding / rate matching for a PDCCH with two TCI states~~
* Option 2 (repetition): Encoding / rate matching is based on one repetition, and the same coded bits are repeated for the other repetition. Each repetition has the same number of CCEs and coded bits, and corresponds to the same DCI payload.
  + Study both intra-slot repetition ~~and inter-slot repetition~~
* ~~Option 3 (multi-chance): Separate DCIs that schedule the same PDSCH /PUSCH /RS/TB/etc. or result in the same outcome.~~
  + ~~Study both cases of DCIs in the same slot and DCIs in different slots~~

Note 1: Companies are encouraged to evaluate the different options based on agreed LLS assumptions for possible down-selection in RAN1#103-e.

Note 2: The actual encoding / rate matching chain for PDCCH polar coding (i.e. 38.212 Sections 5.3.1 / 5.4.1 / 7.3.3 / 7.3.4) is not changed in the options above.

**Agreement**

~~For mTRP PDCCH reliability enhancements, study the following multiplexing schemes~~

* ~~TDM : Two sets of symbols of the transmitted PDCCH / two non-overlapping (in time) transmitted PDCCH repetitions / non-overlapping (in time) multi-chance transmitted PDCCH are associated with different TCI states~~
  + ~~Aspects and specification impacts related to intra-slot vs inter-slot to be discussed~~
* ~~FDM : Two sets of REG bundles / CCEs of the transmitted PDCCH / two non-overlapping (in frequency) transmitted PDCCH repetitions / non-overlapping (in frequency) multi-chance transmitted PDCCH are associated with different TCI states~~
* ~~SFN : PDCCH DMRS is associated with two TCI states in all REGs/CCEs of the PDCCH~~ 
  + ~~Note: There is dependency between this scheme and AI 2d (HST-SFN )~~
* ~~Note: Combinations of the schemes are not precluded, and they can be discussed at a later stage.~~

**Agreement**

~~For Alt 1 (one CORESET with two active TCI states), study the following~~

* ~~Alt 1-1: One PDCCH candidate (in a given SS set) is associated with both TCI states of the CORESET.~~
* ~~Alt 1-2: Two sets of PDCCH candidates (in a given SS set) are associated with the two TCI states of the CORESET, respectively~~
* ~~Alt 1-3: Two sets of PDCCH candidates are associated with two corresponding SS sets, where both SS sets are associated with the CORESET and each SS set is associated with only one TCI state of the CORESET~~
* ~~Note 1: A set of PDCCH candidates contain a single or multiple PDCCH candidates, and a PDCCH candidate in a set corresponds to a repetition or chance~~
* ~~Note 2: How one or more PDCCH candidates are counted for monitoring (for BD limit) is FFS~~ 
  + ~~The note is applicable also to other alternatives~~

**Agreement**

For Alt 1-2/1-3/2/3, study the following

* Case 1: Two (or more) PDCCH candidates are explicitly linked together (UE knows the linking before decoding)
  + FFS: How the explicit linkage is derived/determined by the UE
* ~~Case 2: Two (or more) PDCCH candidates are not explicitly linked together (UE does not know the linking before decoding)~~ 
  + ~~FFS: How the UE knows the linkage after decoding~~

# RAN1 #103-e:

**Agreement**

For PDCCH reliability enhancements, support SFN scheme + Alt 1-1.

* FFS: TCI state activation for CORESET, impact on default beam, BFD resource for BFR

**Agreement**

For PDCCH reliability enhancements with non-SFN schemes, support at least Option 2 + Case 1.

* Maximum number of linked PDCCH candidates is two
* ~~FFS: Details including how the two PDCCH candidates are counted toward the BD limits and impact on overbooking, if any~~
* Down-select at least one Alt from Alts 1-2 / 1-3 / 2 / 3
* ~~FFS: Linking options such as a fixed rule based on the same PDCCH candidate index, based on start CCE, based on configuration, etc.~~ 
  + ~~FFS: additional restriction to facilitate soft combining~~
* ~~FFS: implicit PUCCH resource determination for >8 PUCCH resources in the resource set, scheduling offset for “timeDurationForQCL”, Out-of-order / in-order definition for PDCCH-to-PDSCH and PDCCH-to-PUSCH, DAI for Type-2 codebook, Slot offset  for scheduling the same PDSCH/PUSCH/CSI-RS/SRS, rate matching PDSCH around the scheduling DCI.~~
* ~~FFS: whether and how to support for DCI format 2\_x~~

**Working Assumption**

For PDCCH reliability enhancements with non-SFN schemes and Option 2 + Case 1, support Alt3 (two SS sets associated with corresponding CORESETs).

**Agreement**

~~For PDCCH reliability enhancements with non-SFN schemes and Option 2 + Case 1, CCEs of the two PDCCH candidates are counted separately following Rel. 15/16 procedures. Further study the BD limit by considering the following~~

* ~~With respect to the complexity associated with RE de-mapping / demodulation, 2 units are required~~
* ~~With respect to the complexity associated with decoding, the following assumptions can be further discussed:~~
  + ~~Assumption 1: UE only decodes the combined candidate without decoding individual PDCCH candidates~~
  + ~~Assumption 2: UE decodes individual PDCCH candidates~~
  + ~~Assumption 3: UE decodes the first PDCCH candidate and the combined candidate~~
  + ~~Assumption 4: UE decodes each PDCCH candidate individually, and also decodes the combined~~~~candidate~~
* ~~Note 1: The Assumptions 1-4 are for discussion purpose only, and they may or may not have specification impact.~~
  + ~~FFS: The relationship between UE capability, RRC configuration, and the BD limit, and whether the Assumptions 1-4 are relevant for this purpose.~~
* ~~Note 2: the BD /CCE limit here is counted based on the configuration of PDCCH monitoring capability (e.g. per slot or per span).~~

**Conclusion**

~~Group-common DCI formats (DCI formats 2\_x) are not precluded for multi-TRP PDCCH reliability enhancements and can be discussed with a lower priority compared to UE-specific DCI formats.~~

~~Note: Enhancements required for DCI formats 2\_x, if any, can be discussed case-by-case.~~

**Agreement**

When DL DCI is transmitted via PDCCH repetition (Option2 + Case 1), for PUCCH resource determination for HARQ-Ack when the corresponding PUCCH resource set has a size larger than eight:

* ~~Alt 1: Ensure same start CCE index (based on linking options) and the same number of CCEs in the two CORESETs (based on CORESET configuration restriction)~~
* Alt 2: Starting CCE index and number of CCEs in the CORESET of one of the linked PDCCH candidates is applied
  + FFS:  Which one of the linked PDCCH candidates is used.
* ~~Alt 3: It is up to the UE to determine the PUCCH resource based on the starting CCE index and number of CCEs in the CORESET of any of the two linked PDCCH candidates~~
* Other alternatives are not precluded.

# RAN1 #104-e:

**Agreement**

Confirm the working assumption:

For PDCCH reliability enhancements with non-SFN schemes and Option 2 + Case 1, support Alt3 (two SS sets associated with corresponding CORESETs).

**Agreement**

When DL DCI is transmitted via PDCCH repetition, for PUCCH resource determination for HARQ-Ack when the corresponding PUCCH resource set has a size larger than eight, starting CCE index and number of CCEs in the CORESET of one of the linked PDCCH candidates is applied. Down-select one of the following options in RAN1 #104-bis-e

* ~~Option 1: The one with the lowest CORESET ID is applied~~
* Option 2: The one with the lowest SS set ID is applied.

**Agreement**

For Option 2, at least for the following purposes, a reference PDCCH candidate is defined as the candidate that ends later in time among the two linked PDCCH candidates in the time domain:

* To determine the scheduling offset to identify whether a default beam should be used for PDSCH / CSI-RS reception.
* To extend the definition of in-order for PDCCH-PDSCH and PDCCH-PUSCH, i.e., PDCCH ending symbol is the last symbol of the reference PDCCH candidate in at least the following restrictions in 38.214.
  + For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start receiving a first PDSCH starting in symbol j by a PDCCH ending in symbol I, the UE is not expected to be scheduled to receive a PDSCH starting earlier than the end of the first PDSCH with a PDCCH that ends later than symbol i.
  + For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start a first PUSCH transmission starting in symbol j by a PDCCH ending in symbol I, the UE is not expected to be scheduled to transmit a PUSCH starting earlier than the end of the first PUSCH by a PDCCH that ends later than symbol i.
* For PUSCH preparation time (N2) and CSI computation time (Z): Last symbol of the PDCCH is based on the last symbol of the reference PDCCH candidate.
* ~~FFS: If inter-slot PDCCH repetition is supported, for slot offset for scheduling the same PDSCH/PUSCH/CSI-RS/SRS: The slot of the reference PDCCH candidate is used as the reference slot.~~

**Agreement**

If two PDCCH candidates that are linked for repetition do not belong to the same PDCCH monitoring occasion, the earlier PDCCH monitoring occasion is used as the reference for the following:

* Definition of counter DAI / total DAI and Type-2 HARQ-Ack codebook construction.
* Determining the last DCI for PUCCH resource determination based on the PRI field of the last DCI.

**Agreement**

~~Study whether / how to resolve the following potential issues in the case of PDCCH repetition:~~

* ~~Issue 1: Starting symbol for PDSCH mapping type B as well as reference symbol for SLIV (i.e., when ReferenceofSLIV-ForDCIFormat1\_2 is configured).~~
* ~~Issue 2: Determination of PDSCH beam when TCI field is not present in DCI (when scheduling offset is equal to or larger than timeDurationForQCL)~~
* ~~Issue 3: When PDCCH repetitions are associated with different CORESETPoolIndex values, and the need to use one of them as reference for PDSCH scrambling / CRS rate matching / HARQ-Ack / etc.~~ 
  + ~~Whether PDCCH repetition can be used with multi-DCI based multi-TRP.~~
* ~~Issue 4: Whether single-TRP PDCCH repetition is supported by reusing the agreed framework.~~

**Agreement**

For PDCCH repetition, support linking two SS sets by RRC configuration:

* ~~FFS: Whether MAC-CE can be used additionally~~
* When PDCCH repetition is monitored in two linked SS sets, the UE does not expect a third monitored SS set to be linked with any of the two linked SS sets.
* The two linked SS sets have the same SS set type (USS/CSS)
  + The two linked SS sets have the same DCI formats to monitor
* For intra-slot PDCCH repetition,
  + The two SS sets should have the same periodicity and offset (monitoringSlotPeriodicityAndOffset), and the same duration
  + For linking monitoring occasions across the two SS sets that exist in the same slot:
    - The two SS sets have the same number of monitoring occasions within a slot and n-th monitoring occasion of one SS set is linked to n-th monitoring occasion of the other SS set

**Agreement**

~~For number of BDs corresponding to two PDCCH candidates that are linked for PDCCH repetition, down-select one of the following options in RAN1 #104-bis-e~~

* ~~Option 1: UE reports one or more numbers as required number of BDs for the two PDCCH candidates~~
  + ~~Candidate values: 2, X.~~
    - ~~Where X is a value larger than 2 and equal or less than 3~~
    - ~~FFS: Whether a value between 1 and 2 should be added to the candidate values~~
    - ~~FFS: Other values~~
* ~~Option 2: UE reports whether it supports soft-combining or not~~
  + ~~If soft-combining is supported, UE further reports one or more numbers as required number of BDs for the two PDCCH candidates~~
    - ~~Candidate values: 2, X.~~ 
      * ~~Where X is a value larger than 2 and equal or less than 3~~
      * ~~FFS: Whether a value between 1 and 2 should be added to the candidate values~~
      * ~~FFS: Other values~~
* ~~Option 3: UE reports one or more decoding assumptions out of decoding assumptions 1-4~~
  + ~~Number of BDs for decoding assumptions 1:~~ 
    - ~~Alt1: 2 BDs~~
    - ~~Alt2: A value between 1 and 2 BDs~~
  + ~~Number of BDs for decoding assumption 2: 2~~
  + ~~Number of BDs for decoding assumption 3: 2~~
    - ~~FFS: Other values~~
  + ~~Number of BDs for decoding assumption 4: 3~~
    - ~~FFS: Other values~~
* ~~Option 4: Always 2 BDs are assumed irrespective of UE’s decoding assumption~~
* ~~Option 5: Always 3 BDs are assumed irrespective of UE’s decoding assumption~~
* ~~FFS: Network configuration based on the above UE capabilities for options 1-3~~

~~Note: Specification should not be designed in such a way that the UE is required to disclose it receiver implementation~~

**Agreement**

At least for FR1, if a PDSCH is scheduled by a DCI in PDCCH candidates that are linked for repetition, and the resources in the CORESET(s) containing the PDCCH candidates overlap with the resources of the PDSCH, the PDSCH is rate matched around the union of two PDCCH candidates and the corresponding DMRS.

* Note: This does not imply that two linked PDCCH candidates can / cannot be overlapping in resources, which is a separate discussion.
* FFS: The case of FR2

**Agreement**

When two SS sets are linked for PDCCH repetition, they do not contain individual PDCCH candidates.

* Note 1: For configuration of individual PDCCH candidates, a different SS set can be configured by network.
* Note 2: When one of the linked PDCCH candidates uses the same set of CCEs as an individual PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET, Rel. 15 rule is followed wrt not counting an additional BD.

**Agreement**

For PDCCH repetition, two PDCCH candidates in two SS sets are linked based on

* Having the same AL and the same candidate index:
  + Two linked SS sets are configured with the same number of candidates for each AL.

**Conclusion.**

The agreed PDCCH repetition framework (Option 2 + Case 1 + Alt3) supports both TDM and FDM multiplexing schemes.

# RAN1 #104-b-e:

**Agreement**

When DL DCI is transmitted via PDCCH repetition, for PUCCH resource determination for HARQ-Ack when the corresponding PUCCH resource set has a size larger than eight, starting CCE index and number of CCEs in the CORESET of one of the linked PDCCH candidates is applied, and option 2 is supported

* Option 2: The one with the lowest SS set ID is applied.
* ~~FFS: Support of Option 2 does not mean PDCCH repetition based on two linked search space set within one CORESET is supported~~

**Agreement**

For PDSCH rate matching around the scheduling DCI in the case of PDCCH repetition, the previous agreement for FR1 also applies to FR2.

**Agreement**

For number of BDs corresponding to two PDCCH candidates that are linked for PDCCH repetition, support

* UE reports one [or more] number(s) as required number of BDs for the two PDCCH candidates
  + Candidate values: 2, 3.
* ~~FFS: Default behaviour~~
* ~~FFS: Whether one of the candidate values imply that UE supports soft combining~~
* ~~FFS: Whether additional candidate values are supported (e.g. non-integer numbers)~~
* ~~FFS: RRC configuration based on reported UE capability~~

**Agreement**

If a PDSCH with mapping Type B is scheduled by a DCI in PDCCH candidates that are linked for repetition

* For the purpose of the earliest time that the PDSCH can be scheduled as well as for the purpose of the reference symbol for SLIV (when UE is configured with *ReferenceofSLIV-ForDCIFormat1\_2*, and when receiving the PDSCH scheduled by DCI format 1\_2 with CRC scrambled by C-RNTI, MCS-C-RNTI, CS-RNTI with K0=0), a reference candidate is used. Select one among the following:
  + Alt1: The candidate that starts later in time
  + ~~Alt3: The candidate that starts earlier in time~~
* FFS: How to define *d1,1* for PDSCH processing time in this case

**Agreement**

If a PDSCH is scheduled by a DCI in PDCCH candidates (the first PDCCH candidate associated with a first CORESET and the second PDCCH candidate associated with a second CORESET) that are linked for repetition,

* **Working assumption**: The UE expects the same configuration for the first and second CORESETs wrt presence of TCI field in DCI.
* If the TCI field is not present in the DCI, and the scheduling offset is equal to or larger than timeDurationForQCL if applicable, PDSCH QCL assumption is based on the CORESET with lower ID among the first and second CORESETs
* ~~FFS: Whether additional options are needed (e.g. to enable SDM/FDM/TDM PDSCH schemes w/o TCI field in the DCI)~~

**Agreement**

For a UE supporting reception with two different beams, support identifying two QCL-TypeD properties for multiple overlapping CORESETs

* FFS: How to enhance existing QCL-TypeD priority rules for overlapping CORESETs
* Note: The primary goal of this enhancement for the purpose of this sub-AI is to support time-overlapping PDCCH repetitions in FR2.

**Agreement**

~~When one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET, for the purpose of BD counting and interpretation of a detected DCI, select one option among the following in RAN1#105-e:~~

* ~~Option 1: The individual candidate is not counted for monitoring~~ 
  + ~~Interpretation of the detected DCI is based on Rel. 17 PDCCH repetition rules (wrt reference PDCCH candidate).~~
* ~~Option 2: The candidate in a higher SS set ID is not counted for monitoring~~
  + ~~Interpretation of the detected DCI depends on which candidate is not counted (either based on Rel. 15/16 rules or based on Rel. 17 PDCCH repetition rules).~~
  + ~~FFS: Impact to the other linked PDCCH candidate~~
* ~~Option 3: The candidate associated with SS set(s) with lower priority is not counted for monitoring, where for two linked SS sets, the priority is according to one of the two SS sets with a lower SS set ID~~
  + ~~Interpretation of the detected DCI depends on which candidate is not counted (either based on Rel. 15/16 rules or based on Rel. 17 PDCCH repetition rules).~~
  + ~~FFS: Impact to the other linked PDCCH candidate~~
* ~~FFS: Whether a max limit on number of such overlaps is needed.~~

~~Additional specification support may be introduced for the purpose of resolving ambiguity (if any) for interpretation of the detected DCI. For example,~~

* ~~Distinguished by different RNTIs defined for the linked candidate versus the individual candidate~~
* ~~Distinguished by aggregation level restrictions that can be expected by the UE in the case of overlap~~

**Agreement**

~~For PDCCH repetition with two linked candidates, if due to Rel. 15/16 procedures, one of the linked candidates is not monitored (is dropped), select one option from Options 1 and 2 in RAN1#105-e:~~

* ~~Option 1: UE still monitors the linked candidate that is not dropped and interprets the DCI based on Rel. 17 PDCCH rules (wrt reference PDCCH candidate)~~
* ~~Option 2: Even the candidate that is not dropped is not monitored (Both linked candidates are dropped if at least one of them is dropped)~~
* ~~FFS: Which of the following Rel. 15/16 rules are applicable for this purpose:~~
  + ~~Case 1: Overlap with SSB~~
  + ~~Case 2: Overlap with rate matching resources: RateMatchPattern, lte-CRS-ToMatchAround, or LTE-CRS-PatternList-r16, availableRB-SetPerCell-r16~~
  + ~~Case 3: Due to TDD DL/UL related conflicts: Overlap with semi-static / dynamic UL symbols or overlap with PRACH~~
  + ~~Case 4: QCL-TypeD prioritization rule among CORESETs result in one of the linked candidates not being monitored~~
  + ~~Case 5: Overbooking results in one of the linked candidates not being monitored~~
  + ~~Case 6: Overlap with reserved PRB(s) and OFDM symbol(s) indicated by DCI format 2\_1 where UE may assume no transmission intended for the UE~~
  + ~~Other cases are not precluded~~
* ~~FFS: Whether there is an impact to BD count~~

# RAN1 #106-e:

**Agreement**

If a PDSCH is scheduled by a DCI in PDCCH candidates (the first PDCCH candidate associated with a first CORESET and the second PDCCH candidate associated with a second CORESET) that are linked for repetition:

* Confirm the WA: The UE expects the same configuration for the first and second CORESETs wrt presence of TCI field in DCI.

**Agreement**

For the issues involving a timeline for/related to DCI decoding, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used as a reference. This includes at least the following issues

* For N timeline and the HARQ ACK slot offset in the case that DL DCI does not schedule PDSCH but requests HARQ-Ack: SPS release DCI, SCell dormancy indication, requesting Type-3 HARQ-Ack codebook
* For SPS PDSCH cancelation timeline (14 symbols)
* For PUCCH resource overriding timeline (N3)
* For starting drx-InacitivityTimer
* For timeline to send PRACH in response to PDCCH order
* For PDSCH / AP-CSI-RS reception preparation time with cross carrier scheduling with different SCS’s for PDCCH and PDSCH / AP-CSI-RS, i.e., minimum scheduling delay Npdsch and Ncsirs
* For PHR timeline conditions for virtual versus actual PHR
* For TPC application time window to determine whether a TPC command is applicable or not
* For CPU occupation duration for AP-CSI

For the following issue, the PDCCH candidate that starts earlier in time among the two linked PDCCH candidates is used as a reference:

* For determining the most recent transmission of SRS resource(s) identified by the SRI

**Agreement**

Among the two Alts in RAN1 #104b-e agreement on PDSCH mapping Type B, support Alt1 (The candidate that starts later in time).

**Agreement**

For PDCCH repetition with two linked candidates, if due to Rel. 15/16 procedures, one of the linked candidates is not monitored (is dropped)

* Option 1: UE still monitors the linked candidate that is not dropped and interprets the DCI based on Rel. 17 PDCCH rules (wrt reference PDCCH candidate)
* At least the following Rel. 15/16 rules are applicable for this purpose:
  + Case 1: Overlap with SSB
  + Case 2: Overlap with rate matching resources: RateMatchPattern, lte-CRS-ToMatchAround, or LTE-CRS-PatternList-r16, availableRB-SetPerCell-r16
  + Case 3: Due to TDD DL/UL related conflicts: Overlap with semi-static / dynamic UL symbols or overlap with PRACH
  + FFS: Case 4: QCL-TypeD prioritization rule among CORESETs result in one of the linked candidates not being monitored
  + FFS: Case 6: Overlap with reserved PRB(s) and OFDM symbol(s) indicated by DCI format 2\_1 where UE may assume no transmission intended for the UE
  + Other cases are not precluded
* This does not impact the BD count for both dropped and non-dropped PDCCH candidates

**Agreement**

~~For overbooking in the PCell for USS with two linked SS sets in the same slot/span, select one Alt for each of Case 1 and Case 2 in RAN1 #106-bis-e:~~

* ~~Case 1: 2 BDs are counted for two linked candidates:~~
  + ~~Alt1: No change (use existing spec)~~
  + ~~Alt2: Consider the SS set pair together (both are kept or both are dropped), where the priority is based on lower SS set ID among the pair.~~
* ~~Case 2: 3 BDs are counted for two linked candidates:~~
  + ~~Alt1: Overbooking is per individual SS set as in Rel. 15/16~~
    - ~~Alt1-1: The third BD is counted as a virtual SS set (i.e., the virtual SS set for the third BDs is dopped before dropping the linked SS sets).~~
    - ~~Alt1-2: The third BD is counted as part of the SS set with higher ID.~~
  + ~~Alt2: Consider the SS set pair together (both are kept or both are dropped), where the priority is based on lower SS set ID among the pair.~~
* ~~FFS: Inter-span PDCCH repetition for r16monitoringcapablity.~~

**Agreement**

~~Study whether/how to handle UE complexity / memory requirements for linked PDCCH candidates~~

* ~~The following cases can be considered:~~
  + ~~Case 1: One pair of linked MO’s of one pair of linked SS sets in a given slot with large number of candidates.~~
  + ~~Case 2: Multiple pairs of linked MO’s of one pair of linked SS sets in a given slot, where MO’s of the two SS sets are not interlaced~~
  + ~~Case 3: For two pairs of linked SS sets (e.g. SS sets 1 and 2 are linked, and SS sets 3 and 4 are linked), a MO of any of the SS sets (e.g. SS set 3) is in between two linked MOs of another two SS sets (e.g. SS sets 1 and 2).~~
  + ~~Other cases are not precluded.~~
* ~~Examples of possible mechanisms to address the issue: Restrictions in the spec, UE capability, limit total number linked candidates in a slot, limit total number of linked candidates / CCEs at any given time (similar to CPU occupation)~~
* ~~Whether the solution should also depend on AL of linked candidates~~
* ~~The case of CA can also be considered~~

**Agreement**

SS set configured by *recoverySearchSpaceId* cannot be linked to another SS set for PDCCH repetition.

**Agreement**

For AP-CSI-RS scheduled by two PDCCH candidates that are linked for repetition, the UE does not expect that the AP-CSI-RS is transmitted before the first symbol of the PDCCH candidate that starts later in time.

**Working Assumption**

If a PDSCH with mapping Type B is scheduled by a DCI in PDCCH candidates that are linked for repetition, d1,1 for PDSCH processing time is determined

* Option 2: By considering the PDCCH candidate that results in larger d1,1 value
* Note: Above applies at least for UEs doing selective decoding

~~FFS: Relaxation of processing time for soft combining of linked PDCCH candidates including PUSCH processing, PDSCH processing for mapping Type A and B, AP CSI processing, DCI processing (N timeline), etc.~~

~~FFS: How above applies for UEs doing soft combining~~

**Agreement**

~~For a UE supporting reception with two different beams and configured with PDCCH repetitions, for determination of two QCL-TypeD properties for multiple overlapping CORESETs, down-select from the following Alts in RAN1 #106-bis-e:~~

* ~~Alt1: Identify the two QCL-Type D properties based on legacy priority order.~~
* ~~Alt2: Reuse legacy priority rule to identify the first QCL-TypeD property, and then, identify the second QCL-TypeD according to one of the SS sets that is linked with a SS set with the first QCL-TypeD (among the multiple overlapping CORESETs)~~
  + ~~In the case of multiple such SS set pairs, Rel. 15 priority order is followed for the second QCL-TypeD determination~~
  + ~~FFS: The case of no such SS set pair~~
* ~~Alt3: Assign same priority for two linked search space sets for PDCCH transmission with overlapping monitoring occasions (the priority is according to one of the two SS sets with a lower SS set ID)~~
* ~~Priority order: SS type (USS/CSS) > linkage of SS sets > cell index > associated SS set ID~~
  + ~~Linked SS set has higher priority than individual SS set~~
* ~~FFS: The case that the first QCL-TypeD is from unlinked CSS~~
* ~~FFS: The case of no linked SS sets among the multiple overlapping CORESETs~~

**Agreement**

Support PDCCH repetition for Type3 CSS.

**Agreement**

~~For PDCCH repetition in Rel. 17, study the following aspects:~~

* ~~Whether/how to support PDCCH repetition for Type0/0A/1/2 CSS~~
* ~~Whether to support PDCCH order transmitted with PDCCH repetitions with different beams triggering CFRA for SpCell, and if it is supported how to determine the QCL assumption for the PDCCH that includes the DCI format 1\_0 with RA-RNTI and the corresponding scheduled PDSCH.~~

**Conclusion**

There is no consensus in RAN1 to support inter-slot PDCCH repetition in Rel. 17.

**Agreement**

When one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET

* Interpretation of the detected DCI is based on Rel. 17 PDCCH repetition rules (wrt reference PDCCH candidate).
  + Whether the individual candidate is monitored or not is determined by a UE capability
    - FFS (In UE feature session): The details including reusing the reported number of BDs for this purpose, or relation to reported number of BDs
  + In both cases, the individual candidate is not counted toward the BD limit.
* UE capability for max number of such overlaps is introduced
  + FFS: Value of 0 is included as a candidate value for the UE capability
  + The details to be discussed as part of UE capability discussions
* ~~FFS: When the individual candidate is monitored, the scenario where the other linked candidate is also “overlapping” (same CORESET, DCI size, CCEs, scrambling) with a second individual candidate~~

# RAN1 #106-bis-e

**Agreement**

When 3 BDs are counted for two linked candidates

* The third BD is counted in the later span for inter-span PDCCH repetition when r16monitoringcapablityis configured.
* Note: Inter-span repetition is UE optional

**Agreement**

The following SS sets cannot be linked with another SS set for PDCCH repetition: *SS set 0*, *searchSpaceSIB1*, *searchSpaceOtherSystemInformation*, *pagingSearchSpace*, *ra-SearchSpace*.

**Agreement**

**Confirm the Working assumption in RAN1 #106-e:**

If a PDSCH with mapping Type B is scheduled by a DCI in PDCCH candidates that are linked for repetition, d1,1 for PDSCH processing time is determined

* Option 2: By considering the PDCCH candidate that results in larger d1,1 value
* Note: Above applies at least for UEs doing selective decoding

~~FFS: Relaxation of processing time for soft combining of linked PDCCH candidates including PUSCH processing, PDSCH processing for mapping Type A and B, AP CSI processing, DCI processing (N timeline), etc.~~

~~FFS: How above applies for UEs doing soft combining~~

**Conclusion**

PDCCH order with PDCCH repetitions with different beams triggering CFRA for SpCell is not supported in Rel-17.

**Agreement**

For two pairs of linked PDCCH candidates, UE is not expected to handle the case where a first PDCCH candidate from the first pair of linked candidates to overlap (same CORESET, DCI size, CCEs, scrambling) with a second PDCCH candidate from the second pair of linked candidates.

**For RAN1#107-e:**

Study whether/how to resolve ambiguities for interpretation of a detected DCI for the following cases:

* Case a: SS sets 1 and 2 are linked, and SS set 3 is individual:
  + AL16 candidate in SS set 1 is linked with AL16 candidate in SS set 2
  + SS set 3 has a AL8 candidate with the same start CCE as the AL16 candidate of SS set 1 (associated with a same CORESET with 1-symbol duration)
* Case b: SS sets 1 and 2 are linked, and SS set 3 is individual:
  + AL8 candidate in SS set 1 is linked with AL8 candidate in SS set 2
  + SS set 3 has a AL16 candidate with the same start CCE as the AL8 candidate of SS set 1 (associated with a same CORESET with 1-symbol duration)
* Case c1: SS sets 1 and 2 are linked, and SS set 3 and 4 are linked
  + AL8 candidate in SS set 1 is linked with AL8 candidate in SS set 2
  + AL16 candidate in SS set 3 is linked with AL16 candidate in SS set 4
  + AL8 candidate in SS set 1 has the same start CCE as the AL16 candidate in SS set 3 (associated with a same CORESET with 1-symbol duration)
* Case c2: SS sets 1 and 2 are linked:
  + AL8 candidate in SS set 1 is linked with AL8 candidate in SS set 2,
  + AL16 candidate in SS set 1 is linked with AL16 candidate in SS set 2
  + AL8 candidate and AL16 candidate in at least one of the SS sets have the same start CCE (in a CORESET with 1-symbol duration)

**~~For RAN1#107-e:~~**

~~To handle UE complexity / memory requirements for linked PDCCH candidates, down-select among the following in RAN1 #107-e~~

* ~~Alt1: Address the issue by UE capability, where UE indicates a limit on one of the following~~
  + ~~Alt 1-1: Total number of linked candidates of which the first candidate is received and the second one has not been received at any given time~~
  + ~~Alt1-2: Total number of linked candidates in a slot~~
  + ~~FFS: Whether limit is per CC or across all CCs.~~
  + ~~FFS: Whether limit is per AL or irrespective of AL~~
* ~~Alt2: Address the issue by adding a restriction such as: For a pair of linked MO’s, UE does not expect to be configured with any other linked MO in between the pair of linked MO’s~~
  + ~~FFS: Whether restriction is per CC or across all CCs.~~
  + ~~FFS: Whether the same restriction applies when one or more individual MO’s are in between the pair of linked MO’s~~
* ~~Alt3: The support of PDCCH repetition is indicated separately for different Rel-15/16 PDCCH monitoring capabilities~~
  + ~~Note: This capability may be needed irrespective of this issue but may address the issue at a coarser granularity.~~
* ~~Alt4: There is no need to further discuss this issue~~

**Working Assumption**

When a scheduled CC is configured to be cross-carrier scheduled by a scheduling CC, two PDCCH candidates (with the same AL and candidate index associated with the scheduled CC) are linked only if the corresponding two SS sets in the scheduling CC are linked and two SS sets in the scheduled CC with the same SS set IDs are also linked.

* Note: The PDCCH candidates associated with the scheduled CC are defined as part of SS sets for scheduled CC instead of SS sets for scheduling CC (Same as Rel-15)

**Agreement**

For PDCCH repetition

* When DCI format 2\_1 is detected in linked PDCCH candidates, for determination of set of symbols that interrupted transmission indication in DCI format 2\_1 is applied to, the candidate that starts earlier in time is the reference PDCCH candidate.
* When DCI format 2\_4 is detected in linked PDCCH candidates, for the “first symbol of the PDCCH reception providing the DCI format 2\_4” on the conditions for applicability / validity of cancelation indication in 38.213 (which is relative to a DCI format that schedules PUSCH/SRS), the candidate that starts earlier in time is the reference PDCCH candidate.
* The following legacy rule is followed when the candidate that ends later in time is received outside the first three symbols of the slot: “38.214: When the DCI format 0\_1 or 1\_1 with 'Minimum applicable scheduling offset indicator' field is received outside the first three symbols of the slot, value of Zµ from Table 5.3.1-1 is incremented by one before determining the application delay X”

**Agreement**

~~Further study the following issues for PDCCH repetition:~~

* ~~Issue a: QCL-Type D assumption for CSI-RS with higher layer parameter repetition is not set to 'on' when it overlaps with multiple CORESETs with different QCL-TypeD.~~
* ~~Issue b: For PDCCH repetition of DCI format 1\_0 on two linked CSS, in order to determine the value of for mapping VRB to PRB of a scheduled PDSCH~~
* ~~Issue c: PDSCH rate matching on resources that overlaps with scheduling PDCCH resources if this corresponding PDCCH candidate is dropped due to interruption~~
* ~~Issue d: With Type-1 HARQ-ACK codebook, and the SPS release PDCCH repetition, to determine the location of the HARQ-ACK bit of the SPS release PDCCH~~

**Conclusion**

There is no consensus to introduce RRC configuration for the number of BDs.

**Agreement**

For overbooking in the PCell for USS with two linked SS sets in the same slot/span, support:

* Case 1: 2 BDs are counted for two linked candidates:
  + No change (use existing spec)

**Agreement**

For a UE supporting reception with two different beams and configured with PDCCH repetitions, for determination of two QCL-TypeD properties for multiple monitored overlapping CORESETs, support

* Alt2: Reuse legacy priority rule to identify the first QCL-TypeD property, and then, identify the second QCL-TypeD according to one of the SS sets that is linked with a SS set with the first QCL-TypeD (among the multiple overlapping CORESETs)
  + In the case of multiple such SS set pairs, Rel. 15 priority order is followed for the second QCL-TypeD determination
  + In the case of no such SS set pair, a second QCL-TypeD is not determined
* Note 1: simultaneous two beam reception for PDCCH repetition is UE optional
* Note 2: It can be separately discussed whether/how this feature interacts with multi-DCI based mTRP or with SFN PDCCH

**Agreement**

For PDCCH repetition

* When DCI format 2\_4 is detected in linked PDCCH candidates, for determination of set of symbols that cancelation indication in DCI format 2\_4 is applied to, the candidate that ends later in time is the reference PDCCH candidate
* When the DCI format that triggers a SS set group switching is detected in linked PDCCH candidates, for the switching timeline (P\_switch), the candidate that ends later in time is the reference PDCCH candidate
* When a DCI format 2\_2/2\_3 with TPC command is detected in linked PDCCH candidates, to determine whether the TPC command is within the TPC application time window or not, the candidate that ends later in time is the reference PDCCH candidate
* For timeline between PDCCH spans carrying BWP switching and CSI trigger respectively, take the span that involves the PDCCH candidate that ends later in time as the reference
* To determine the conditions for receiving SPS PDSCH release DCI and the SPS PDSCH in the same slot, the PDCCH candidate that ends later in time must end before the end of the SPS PDSCH

# RAN1 #107-e

**Agreement**

Confirm the following working assumption in RAN1 #106-bis-e:

When a scheduled CC is configured to be cross-carrier scheduled by a scheduling CC, two PDCCH candidates (with the same AL and candidate index associated with the scheduled CC) are linked only if the corresponding two SS sets in the scheduling CC are linked and two SS sets in the scheduled CC with the same SS set IDs are also linked.

* Note: The PDCCH candidates associated with the scheduled CC are defined as part of SS sets for scheduled CC instead of SS sets for scheduling CC (Same as Rel-15)

**Agreement**

To address the ambiguity issue between AL8 and AL16 candidates in the presence of PDCCH repetition:

* For two linked AL8 PDCCH candidates in a first and second SS sets and two linked AL16 candidates in a third and fourth SS sets, UE expects different starting CCEs in a CORESET for any of the linked AL8 candidates and any of the linked AL16 candidates if the CORESET spans one OFDM symbol (i.e., Case c1 is not expected by UE) and is non-interleaved
* If two PDCCH candidates with AL8 and AL16 have the same start CCE in a non-interleaved CORESET with one OFDM symbol:
  + When at least one of the AL8 or AL16 candidates is linked with other PDCCH candidate, and UE receives a DCI on any of the AL8 or AL16 candidates, a scheduled PDSCH by the DCI is rate matched around the AL16 candidate and any PDCCH candidate linked with any of the AL8 or AL16 candidates (i.e., rate matching in Cases a, b and c2 is around the union of candidates)
  + When one of the AL8 candidate or the AL16 candidate is linked to another PDCCH candidate for PDCCH repetition (i.e., Cases a or b), interpretation of a detected DCI via any of the first or second PDCCH candidates is based on Rel. 17 PDCCH repetition rules (wrt reference PDCCH candidate).
    - FFS (to be resolved in this meeting): Whether/how to resolve potentially ambiguity for PUCCH resource determination for Case c2

**Agreement**

To handle UE complexity / memory requirements for linked PDCCH candidates, address the issue by UE capability, where UE indicates a limit (X) associated with the total number of linked candidates of which the first candidate is received and the second one has not been received at any given span.

* The limit X is indicated as a total count assuming count 1 for AL=1; 2 for AL=2; 4 for AL=4 or 8 or 16.
* The limit X is indicated per CC and also across all CCs
* Note: “received” and “not been received” is wrt the end of the corresponding span of PDCCH candidate.
* Above is applicable at least for the inter-span case (FFS: intra-span case)

**Agreement**

Two linked PDCCH candidates are not expected to be associated with different *CORESETPoolIndex* values.

**Agreement**

For overbooking in the PCell for USS with two linked SS sets in the same slot/span, support:

* Case 2: 3 BDs are counted for two linked candidates:
  + Overbooking is per individual SS set as in Rel. 15/16
    - The third BD is counted as part of the SS set with higher ID.

**Agreement**

For PDCCH repetition

* If two linked PDCCH candidates schedule a PDSCH with mapping Type A in a same slot, both linked PDCCH candidates are expected to be contained within the first three symbols of the slot.
* Use candidate that ends later in time for active NZP CSI-RS resource / port determination, and for CPU occupation duration for first instant of SP-CSI on PUSCH
  + Note: The case of CPU occupation duration for AP-CSI is agreed before
* When BFR response is detected in PDCCH candidates that are linked for PDCCH repetition (applicable to CBRA-based BFR in the PCell/PSCell, or Scell BFR), the beam / power control reset for PUCCH/PDCCH (when applicable) occurs after 28 symbols from the last symbol of the PDCCH candidate that ends later in time.
* When DCI carrying DFI is detected in PDCCH candidates that are linked for PDCCH repetition, the candidate that starts earlier in time is used as the reference PDCCH candidate for determination of validity of DFI for a PUSCH with a given HARQ process number.

**Conclusion**

For the following restriction in 38.213, two linked PDCCH candidates are counted as one PDCCH: “For a scheduled cell and at any time, a UE expects to have received at most 16 PDCCHs for DCI formats with CRC scrambled by C-RNTI, CS-RNTI, or MCS-C-RNTI scheduling 16 PDSCH receptions for which the UE has not received any corresponding PDSCH symbol and at most 16 PDCCHs for DCI formats with CRC scrambled by C-RNTI, CS-RNTI, or MCS-C-RNTI scheduling 16 PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol.”

**Agreement**

For cross-carrier scheduling, *searchSpaceSharing* is not applicable if at least one scheduled CC is configured with PDCCH repetition.

**Conclusion**

For two linked SS sets are configured with respective *searchSpaceGroupIdList*,

* If both SS sets are monitored in a search space set group, then PDCCH repetition mechanism is applied for the linked SS sets
* If only one of the two SS sets is monitored in a search space set group, then the legacy PDCCH mechanism is applied for the monitored one (i.e., no PDCCH repetition)

**Conclusion**

There is no consensus in Rel-17 to relax the restriction that PDCCH repetitions should be received within the first 3 symbols of a slot for indicating active BWP change.

**Conclusion**

Simultaneous configuration of SFNed CORESET and PDCCH repetition in the same CC, or in different CCs for intra-band CA in FR2 is not supported in Rel-17.

**Agreement**

For two CORESETs associated with two linked CSS, the CORESET with lower ID is used for the following purposes:

* To determine the value of for mapping VRB to PRB of a PDSCH scheduled by DCI format 1\_0.
* To determine the uplink RB set of a PUSCH scheduled by DCI format 0\_0 (with CRC scrambled by an RNTI other than TC-RNTI) for UL resource allocation type 2.