**3GPP TSG-RAN WG4 Meeting # 109 R4-2318184**

**Chicago, USA, November 13 – November 17, 2023**

**Agenda item:** 8.29.5

**Source:** Moderator (Samsung)

**Title:** Topic summary for [109][228] NR\_MIMO\_evo\_DL\_UL

**Document for:** Information

# Introduction

This topic summary covers the contributions submitted under the following AI for RRM of Rel-18 MIMO evolution for downlink and uplink:

* 8.29.2 RRM core requirements
* 8.29.2.1 RRM requirements impacts

\* Except aspects covered in AI 8.29.2.2 and AI 8.29.2.3

* 8.29.2.2 Timing requirements for UL multi-DCI multi-TRP with two TAs
* 8.29.2.3 Unified TCI framework
* 8.29.3 RRM performance requirements

# Topic #1: Feasibility study of TDCP accuracy

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318583 | Apple | Observation #1: The accuracy requirements for RRM are agnostic to propagation channel condition and applicable to a range of SNR. Observation #2: The feasibility study of defining accuracy requirements for TDCP measurement is limited to TDL channel model.Observation #3: Defining an accuracy requirement for TDCP measurement in a certain channel model is inadequate and not useful in real deployment.Observation #4: Testability issue with defining such accuracy requirements as static channel conditions are used for accuracy requirements and TDCP measurement accuracy would need a TDL channel.Observation #5: Using a fading channel for accuracy requirement test might lead to false errors, as the measurement can change with channel conditions.Observation #6: Simulation results show that the TDCP measurement is very sensitive to SNR and depends on channel model and Doppler.Observation #7: It is not feasible to define accuracy requirements for TDCP measurement that would be applicable to a range of SNR, and all channel conditions.Proposal #1: Do not define accuracy requirements for TDCP measurement.  |
| R4-2318849 | xiaomi | Observation 1: The ideal mean value or median value derived from TDL-A model is close to ideal value derived from Bessel function.Proposal 1: Ideal mean/median value can be derived from TDL-A channel without noise. The ideal mean value or median value derived from TDL-A model is close to ideal value derived from Bessel function.Observation 2: For low doppler case, e.g. smaller than 30Hz, the ideal correlation value distribution will concentrate to 1 with small variation. it’s possible to use a constant value over time as ideal value.- For doppler = 10Hz, ideal correlation value span from 0.9958 to 1 with range = 0.0042 in 95% cases, - For doppler = 30Hz, ideal correlation value span from 0.9677 to 0.9998 with range = 0.0321 in 90% casesObservation 3: For high doppler case, large than 75Hz, the ideal value distribution will be more diverse. Then it’s hard to use a constant value as ideal value over time.- For doppler = 75Hz, ideal correlation value span from 0.8023 to 0.9987 with range = 0.1964in 90% cases- For doppler = 100Hz, ideal correlation value span from 0.7808 to 0.9981 with range = 0.2173 in 90% cases- For doppler = 200Hz, ideal correlation value span from 0.5533 to 0.9921 with range = 0.4388 in 90% cases- For doppler = 300Hz, ideal correlation value span from 0.4749 to 0.9755 with range = 0.5006 in 90% casesProposal 2: It’s possible to use a constant value over time as ideal value for low doppler case, e.g. smaller than 30Hz. It’s hard to use a constant value as ideal value for high doppler case, e.g. larger than 75Hz.Observation 4: With higher SNR level, instant estimated correlation error will decrease.- At SNR = 20dB, estimated error can be less than 0.05 at CDF = 90% for all dopplers- At SNR = 15dB, estimated error can be less than 0.14 at CDF = 90% for all dopplers- At SNR = 10dB, estimated error can be less than 0.35 at CDF = 90% for all dopplers- At SNR = 5dB, estimated error can be less than 0.62 at CDF = 90% for all dopplersObservation 5: if TDCP instant accuracy test will be defined, SNR should be higher than 15dB.Observation 6: For TDCP instant accuracy test for doppler = 10Hz:- For SNR = 20dB, if the threshold is defined in terms of value without quantization, delta=0.05 corresponding to CDF=90%. if the threshold is defined in terms of index, index delta will be 7.- For SNR = 15dB, if the threshold is defined in terms of value without quantization, delta=0.14 corresponding to CDF=90%. if the threshold is defined in terms of index, index delta will be 9.Proposal 3: For TDCP instant accuracy test, e.g. doppler = 10Hz, the accuracy delta with high SNR is still large compared with quantization step.Observation 7: The mean value delta for all dopplers are:- For SNR = 20dB, without quantization, delta is smaller than 0.0218. - For SNR = 15dB, without quantization, delta is smaller than 0.0629. - For SNR = 10dB, without quantization, delta is smaller than 0.1527. - For SNR = 5dB, without quantization, delta is smaller than 0.3237. Observation 8: The mean value delta after quantization may increase 0.01~0.04:- For SNR = 20dB, after quantization, delta is smaller than 0.0404 - For SNR = 15dB, after quantization, delta is smaller than 0.0725 - For SNR = 10dB, after quantization, delta is smaller than 0.1937- For SNR = 5dB, after quantization, delta is smaller than 0.3552Observation 9: It’s possible to plot the CDF curve of estimated values. Then compare the estimated CDF curve with ideal CDF curve for CDF = 10%,50% and 90% points. However, this kind of method is a little complex.Observation 10: It’s hard to justify whether the estimated results are accurate or not if the threshold is defined only based on the estimated value.Proposal 4: It’s possible to compare estimated value with ideal value by different types of metrics. RAN4 to discuss the necessity to define accuracy test with large delta compared with quantization step. |
| R4-2319215 | Samsung | Observation 1: Estimated TDCP amplitude range is affected by the factors such as SNR, Doppler.Proposal 1: It cannot define a common accuracy requirement for TDCP amplitude reporting to cover all conditions. The accuracy is only can be applicable under a certain condition. In RRM requirements, usually the requirements are applicable for all conditions when SNR > side condition. To decide whether can define an accuracy requirement in a certain condition in this meeting.  |
| R4-2319621 | MediaTek Inc. | Observation 1: The TDCP amplitude distribution with averaging four samples is more converge and smooth than one sample method.Observation 2: The TDL-D channel will lead to TDCP amplitude value closed to 1 since the LOS path with large power dominates the channel.Proposal 1: It is not possible to use TDCP amplitude to estimate UE speed (corresponding to doppler shifts) in TDL-D channels.Observation 3: The TDCP amplitude distribution is quite different between TDL-A and TDL-D when doppler (>=75Hz).Observation 4: The faster UE moves, the higher false rate will be at high SNR.Observation 5: For the doppler (<75Hz), the higher CDF get less estimation error.Observation 6: For the doppler (>=75Hz), the less estimation error is near the CDF (50%).Observation 7: With low speed (5 km/h), false rate is high under low SNR and false rate is low under high SNR.Observation 8: The fast UE moves, false rate is higher under high SNR and lower under low SNR.Observation 9: It is difficult to define the accuracy requirements for TDCP that guarantee low false rates for all the concerned speed.Observation 10: TDCP amplitude values will vary a lot with different SNR and channel status (LOS/NLOS) but not only different doppler shifts.Proposal 2: Do not define the accuracy requirement for TDCP reporting as this is not feasible. |
| R4-2320726 | Nokia, Nokia Shanghai Bell | Observation 1: TDCP is calculated as the normalized time correlation function from 2 or more channel measurements estimated based on TRS.Observation 2: The expected (ideal) value is a function of the UE speed, the details of the channel model, and the noise level.Observation 3: If the channel is a frequency flat, then the theoretical time correlation is the Bessel function which yields the classic Doppler spectrum. The Bessel function values could be used as the ideal correlation values but would need to be degraded according to the SNR.Observation 4: The ideal value of TDCP is obtained by using the Bessel function and this autocorrelation depends on doppler spread denoted as $f\_{max}=f\_{c}∙\frac{v}{c}$ and the delay ($∆t$).Observation 5: Using the TDL channel model allows us to apply the Bessel function without any need for simulations to obtain the ideal TDCP values.Observation 6: There is a deviation between the ideal values and the simulated noise free values which may be attributed to the fact that the ideal values are calculated from the Bessel function without taking into account the taps.Observation 7: The difference between the ideal values and the median of the simulated noise free values is below 2 quantization levels.Observation 8: Simulation results with TDLA-30 and maximum Doppler frequency from 10 Hz to 300 Hz have shown large span in TDCP values. Observation 9: Simulation results with different SNRs shown nearly no impact in SNR variation for the simulated scenario. Proposal 1:RAN4 to evaluate TDCP feasibility with * 1. 2 and 4 averaging samples
	2. Investigating different lags between TRS symbols
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| R4-2320779 | Ericsson | Proposal 1: RAN4 to agree that ideal value can be calculated for each delay value and over different doppler spread (*fmax)*.Proposal 2: RAN4 to define TDCP accuracy requirements as * 1. TDCP observed from simulation results are within acceptable range from the ideal value; and
	2. it is possible to define the accuracy requirements that can be tested using the ideal value derived from Bessel function as reference.
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| R4-2320963 | Qualcomm Incorporated | Observation 1: For a given Doppler spread, in higher SNR than 5dB, the distributions of TDCP results for different SNR conditions do not significantly deviate.Observation 2: The deviation of the distributions of TDCP results increases as the Doppler spread increases. And the deviation can be reduced by averaging TDCP over multiple measurement occasions.Observation 3: At the highest Doppler spread (300Hz), the deviation of the estimated TDCP, at 50% in TDD, from the expected auto-correlation value based on Jakes model (see Fig. 3) is larger than FDD due to the smaller number of TRS resources in the frequency domain.Observation 4: CDF of TDCP for low Doppler spreads at 10% point overlaps with CDF of TDCP for high Doppler spreads at 90%.Observation 5: For the basic lag distance (1 slot delay), the auto-correlation differences between Doppler spread 75Hz and 300Hz are approximately 0.05 and 0.2 for TDD and FDD, respectively. Proposal 1: If agreed to define TDCP accuracy requirement, the requirement and corresponding tests are defined based on the following framework:* Two Doppler spread values, one for a low Doppler spread and the other for a high Doppler spread, should be chosen. e.g. [30Hz or 75Hz] and 300Hz.
* The requirement is defined such that 50% of CDF of the reported TDCP values (more than X TDCP samples over Y sec) is within Z1 and Z1. FFS on X, Y, Z1, and Z2.
* The requirement is applicable at SNR > 5dB.
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| R4-2319968 | Huawei, HiSilicon | Proposal 1: It is suggested not to define measurement accuracy requirements for TRS based TDCP reporting. |

## Open issues summary

### Sub-topic 1-1

**Issue 1-1-1: Is it feasible to define TDCP accuracy requirement for TDCP?**

* Proposals
	+ Proposal 1: (Apple, MediaTek, Huawei)
		- Not feasible. Do not define accuracy requirements for TDCP measurement.
	+ Proposal 2: (Ericsson, Qualcomm)
		- Yes. It is feasible. Define TDCP accuracy requirements.
		- Proposal 2a: Ericsson
			* TDCP observed from simulation results are within acceptable range from the ideal value; and
			* it is possible to define the accuracy requirements that can be tested using the ideal value derived from Bessel function as reference.
		- Proposal 2b: Qualcomm
			* Two Doppler spread values, one for a low Doppler spread and the other for a high Doppler spread, should be chosen. e.g. [30Hz or 75Hz] and 300Hz.
			* The requirement is defined such that 50% of CDF of the reported TDCP values (more than X TDCP samples over Y sec) is within Z1 and Z1. FFS on X, Y, Z1, and Z2.
			* The requirement is applicable at SNR > 5dB.
	+ Proposal 3: (others)
		- RAN4 to discuss the necessity to define accuracy test with large delta compared with quantization step. (Xiaomi)
		- It cannot define a common accuracy requirement for TDCP amplitude reporting to cover all conditions. The accuracy is only can be applicable under a certain condition. In RRM requirements, usually the requirements are applicable for all conditions when SNR > side condition. To decide whether can define an accuracy requirement in a certain condition in this meeting. (Samsung)
		- RAN4 to evaluate TDCP feasibility with (Nokia)
			* 2 and 4 averaging samples
			* Investigating different lags between TRS symbols

*Moderator’s summary of simulations:*

Table in: only TDL-A and one shot (if not the only config) are captured for comparison, others can be found in contributions.

Observation:

* Different estimated TDCP depends on [SNR], channel conditions, Doppler spread
	+ Nokia, Qualcomm, Ericsson: correlation results are almost at the same level for different SNR;
		- LS+Noise suppression is used in Ericsson’s, not sure for others
	+ Apple, Xiaomi, Huawei, MediaTek: correlation results vary in different SNR level. Lower SNR have the worse performance.
	+ Correlation decreased as doppler spread increased.

Firstly, all companies have proved the accuracy are different in different condition such as channel model and Doppler spread and [SNR]. It cannot define a uniform accuracy requirement.

RAN4 to decide whether RRM accuracy requirements can be accepted in a certain condition.

**Issue 1-1-2: How to achieve ideal value of TDCP reporting?**

* Proposals
	+ Proposal 1: (Xiaomi)
		- Ideal mean/median value can be derived from TDL-A channel without noise. The ideal mean value or median value derived from TDL-A model is close to ideal value derived from Bessel function.
		- It’s possible to use a constant value over time as ideal value for low doppler case, e.g. smaller than 30Hz. It’s hard to use a constant value as ideal value for high doppler case, e.g. larger than 75Hz.
	+ Proposal 2: (Nokia, Ericsson, MediaTek)
		- Using Bessel function depends on doppler spread denoted as $f\_{max}=f\_{c}∙\frac{v}{c}$ and the delay ($∆t$).

# Topic #2: Timing requirements for UL multi-DCI multi-TRP with two TAs

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318615 | Apple | Observation 1: two TAs can be supported only if actual RTD/TTD is no larger than the limit that UE can support, e.g. RTD <= CP for baseline UE.Observation 2: deployment of mTRP with two TAs is different from legacy LTE CA. Therefore, it is inefficient to reuse LTE CA solution.Observation 3: besides MIMO with 2TAs, UE capability or RAN4 requirement side condition of RTD<CP has also been widely used in many other R18 work items, such as NR further mobility enhancement, multi-Rx and so on.Proposal 1: RAN4 shall consider some solution regarding RTD monitoring.• One solution for example:• UE indicates its category to NW after access NW (baseline UE or advanced UE).• Network configures UE to monitor RTD between the two TRPs. • UE monitors the RTD consistently, and report to network when status changes (e.g. RTD becomes larger/smaller than CP for baseline UE)• Upon receiving RTD status change from UE, network can update configuration accordingly (e.g. fallback to single TAG or enable two TAGs).Proposal 2: consider RTD monitoring in R19. |
| R4-2319216 | Samsung | Proposal 1: When the transmission timing difference between two TAGs for multi-TRP operation exceeds the MTTD value, no RAN4 requirements which is the same as NR CA and it is up to UE implementation. |
| R4-2319622 | MediaTek Inc. | Proposal 1: When the uplink transmission timing difference between two TAGs exceeds the capability UE can support, do not define additional RRM requirements. It’s up to UE implementation on how to handle this case. |
| R4-2319636 | Ericsson | Observation 1: Agreed DL reference timing text:* For multi-DCI based multi-TRP operation with two TAs, for each TAG, the uplink transmission timing takes place before the reception of the first detected path (in time) of the corresponding downlink frame of the reference signal associated with UL/joint TCI state.

is inserted in introduction and subsequent paragraphs. Observation 2: For capable UE, however, it has already been agreed that capable UEs shall be able to handle the same MTTD as for CA interband.Proposal 1: TAG management for multi-TRP with 2 TAs, when the transmission timing difference between two TAGs for multi-TRP operation exceeds the MTTD value, can be left to UE implementation. |
| R4-2319966 | Huawei, HiSilicon | Proposal 1: For TAG management for multi-TRP with 2 TAs, there is no need to define requirements and it is up to UE implementation when the transmission timing difference between two TAGs for multi-TRP operation exceeds the MTTD value. |
| R4-2320729 | Nokia, Nokia Shanghai Bell | Proposal 1: Modify the RAN4#108bis “Issue 3-1-1: DL reference timing” agreement text to (modifications are in italics):- For multi-DCI based multi-TRP operation with two TAs, for each TAG, the uplink transmission timing takes place  before the reception of the first detected path (in time) of the corresponding downlink frame of the reference signal associated with the ***indicated*** UL/joint TCI state ***associated with that*** TAG.Proposal 2: For multi-DCI based multi-TRP operation with two TAs, the UE is required to maintain a DL reference timing for a TAG as soon as one TCI state corresponding to that TAG is activated/indicated.Observation 1: Reusing CA solution by leaving up to UE implementation which UL transmission needs to be stopped when transmission timing difference between the two TAGs exceeds the MTTD value is not efficient.Proposal 3: Define a rule such that UE and network know which UL transmission the UE will stop when the transmission timing difference between the two TAGs exceeds the MTTD value.Proposal 4: Adopt at least one of the following options for the rule defining which UL transmission the UE will stop when the transmission timing difference between the two TAGs exceeds the MTTD value:• The UE stops the UL transmission corresponding to the TAG with lowest or highest TAG index or ID.• The UE stops the UL transmission corresponding to the TAG associated (e.g., through TCI states) with lowest or highest coresetPoolIndex. |
| R4-2320964 | Qualcomm Incorporated | Proposal 1: The number of downlink timing references should be equal to the number of TAGs across CCs. |

## Open issues summary

### Sub-topic 2-1

**Issue 2-1-1: TAG management for multi-TRP with 2 TAs**

* Proposals
	+ Proposal 1: (Apple)
		- consider RTD monitoring in R19
			* UE indicates its category to NW after access NW (baseline UE or advanced UE).
			* Network configures UE to monitor RTD between the two nodes.
			* UE monitors the RTD consistently, and report to network when status changes (e.g. RTD becomes larger/smaller than CP)
			* Upon receiving RTD status change from UE, network can update configuration accordingly (e.g. fallback to single TAG or enable two TAGs).
	+ Proposal 2: UE implementation (Samsung, MediaTek, Ericsson, Huawei)
		- When the transmission timing difference between two TAGs for multi-TRP operation exceeds the MTTD value, there is no need to define requirements and it is up to UE implementation.
	+ Proposal 3: (Nokia)
		- Define a rule such that UE and network know which UL transmission the UE will stop when the transmission timing difference between the two TAGs exceeds the MTTD value.
		- Adopt at least one of the following options for the rule defining which UL transmission the UE will stop when the transmission timing difference between the two TAGs exceeds the MTTD value:
			* The UE stops the UL transmission corresponding to the TAG with lowest or highest TAG index or ID.
			* The UE stops the UL transmission corresponding to the TAG associated (e.g., through TCI states) with lowest or highest coresetPoolIndex.
* Recommended WF
	+ TBA

**Issue 2-1-2: Number of downlink timing reference**

* Proposals
	+ Proposal 1: (Qualcomm)
		- The number of downlink timing references should be equal to the number of TAGs across CCs.
* Recommended WF
	+ TBA

**Issue 2-1-3: Additional UE behaviour for DL reference timing**

* Proposals
	+ Proposal 1: (Nokia)
		- For multi-DCI based multi-TRP operation with two TAs, for each TAG, the uplink transmission timing takes place  before the reception of the first detected path (in time) of the corresponding downlink frame of the reference signal associated with the ***indicated*** UL/joint TCI state ***associated with that*** TAG.
		- For multi-DCI based multi-TRP operation with two TAs, the UE is required to maintain a DL reference timing for a TAG as soon as one TCI state corresponding to that TAG is activated/indicated.
* Recommended WF
	+ - TBA

Moderator’s suggestion:

[Background in RAN4#108-bis]: In last meeting, the companies agree the agreement in WF in last meeting with not to introduce the additional UE behaviour in RAN4 spec.

# Topic #3: Unified TCI Framework extended to M-TRP

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318584 | Apple | **Multi-DCI mTRP**Observation 1: For multi-DCI both intra-cell and inter-cell cases are considered. SSBs could be overlapped or adjacent for both cases with and without 2TA support.Observation 2: Need to account for extra delay in case the SSBs are overlapping or adjacent for mDCI irrespective of 2TA support.Observation 3: The delay requirement needs to consider and additional SSB period depending on the periodicities of the overlapping SSBs. Observation 4: For 2TA case UE has 2 TAG and 2 DL reference timing.Observation 5: The TCI states(s) for each coresetPoolIndex are associated with a TAG. Observation 6: The UE needs use the DL reference timing for each coresetPoolIndex for UL timing.Observation 7: The DL reference timing RS should be in the DL active TCI state list.Observation 8: For joint TCI state, the UE would track timing since its needed for DL reception and is already considered in the DL switching requirements.Observation 9: For separate UL TCI state switch additional time is needed – if the RS is not in or QCLed to RS in DL active TCI list. Observation 10: For UE supporting RTD>CP, the requirements are the same as RTD<CP, with the side condition of RTD<CP removed. Proposal 1： For mDCI without 2TA Unified TCI state switching delay: - DL switch, known case: THARQ + $3N\_{slot}^{subframe,µ}$+ TOk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB- DL switch unknown case: THARQ + $3N\_{slot}^{subframe,µ}$+ TL1-RSRP + TOuk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB- UL switch known case: Same as R17- UL switch unknown case: Same as R17Proposal 2: For mDCI with 2TA the Unified TCI state switching delay: - DL switch, known case: THARQ + $3N\_{slot}^{subframe,µ}$+ TOk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB- DL switch unknown case: THARQ + $3N\_{slot}^{subframe,µ}$+ TL1-RSRP + TOuk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB- UL switch known case: THARQ + $3N\_{slot}^{subframe,µ}$ + TOk-ref (Tfirst-SSB-DLRef + 2ms)+NM\*( Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms)- UL switch unknown case: THARQ + $3N\_{slot}^{subframe,µ}$ + TL1-RSRP + TOuk-ref (Tfirst-SSB-DLRef + 2ms)+ Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms**Single-DCI mTRP**Observation 1: Stating that longer delay is expected doesn’t provide any information on the expected delay. We should strive to define a delay requirement if feasible.Proposal 3: For case 1 extend the delay requirements to account for adjacent SSBs in FR2 as: THARQ + $3N\_{slot}^{subframe,µ}$ + max{TOk1\*(Tfirst-SSB1 +AD1\*TSSB1+ TSSB-proc), TOk2\*(Tfirst-SSB2 +AD2\*TSSB2+ TSSB-proc)} / NR slot lengthProposal 4: Dual TCI state switch requirements for sDCI are defined for the case when UE is expected to receive from both TCI states/ TRPs after the switch. Proposal 5: For case 2 the following delay requirements are introduced:Case 2a (TSSB1 ≤ TSSB2): THARQ + $3N\_{slot}^{subframe,µ}$ + TL1-RSRP1 +max{TOuk1\*(Tfirst-SSB1+ AD1\*TSSB1 + TSSB-proc), TOk2\*(Tfirst-SSB2 + TSSB-proc)} / NR slot length; AD1 = 1 if SSBs are adjacent in FR2 and TSSB1 ≤ TSSB2 ; 0 otherwiseCase 2b (TSSB1 > TSSB2): THARQ + $3N\_{slot}^{subframe,µ}$ + max{TL1-RSRP1 + TOuk1\*(Tfirst-SSB1+ TSSB-proc), TOk2\*(Tfirst-SSB2 + TSSB-proc)} / NR slot length;Observation 2: It is not simple to come up with delay requirements to account for adjacent SSBs in FR2 for case where both TCI sates are unknown.Proposal 6: For case 3 with adjacent SSBs, longer delay is expected.  |
| R4-2318850 | xiaomi | Observation 1: In legacy scheduling availability in SSB based L3 measurement for FR1, there is also no scheduling restriction if UE support *simultaneousRxDataSSB-DiffNumerology* capability, e.g. clause 9.2.5.3.2. For SSB based L3 measurement, there is no timing offset limitation.Proposal 1: When timing offset can be larger than CP, for mixed numerology case, if UE support *simultaneousRxDataSSB-DiffNumerology* capability, UE can perform measurement without restriction and doesn’t need RTD>CP capability.Observation 2: When UE does not support *simultaneousRxDataSSB-DiffNumerology* capabilitybut UE supports *RTD>CP* capability, it’s possible that UE can still process two signals.Proposal 2: RAN4 to discuss whether UE can process two signals when UE does not support *simultaneousRxDataSSB-DiffNumerology* capabilitybut UE supports *RTD>CP* capability.Proposal 3: In FR1, if timing offset is larger than CP and UE incapable of *RTD>CP capability*, measurement period for SSB based measurement from serving cell and cell with different PCI will be scaled by 2 when overlapped. The confliction case will include SSB based measurement for L1-RSRP/BFD/CBD/RLM.Proposal 4: in FR1, if timing offset is larger than CP and UE incapable of *RTD>CP capability*, define measurement restriction when SSB from cell with different PCI is overlapped with CSI-RS from serving cell.Proposal 5: If RTD>CP, for sDCI, when two SSBs are overlapped or adjacent, one more SSB for TCI activation is needed.Proposal 6: For mDCI, UE is not expected to receive or transmit data when conflicting with SSB for T/F tracking or PL-RS for pathloss calculation before UE finish two TCI state activations. |
| R4-2319217 | Samsung | Proposal 1: For inter-cell scenario, RTD>CP case, update the applicability of timing depends on UE capability. Reuse Rel-17 ICBM sharing for SSBs are overlapping or adjacent. When perform L1-RSRP for the additional PCI with RTD>CP, introduce one or two more symbols for scheduling restriction. All other requirements in Rel-17 can be reused.Proposal 2: For intra-cell scenario, RTD>CP case, reuse similar Rel-17 ICBM sharing for SSBs are overlapping or adjacent by sharing factor of 2. When perform L1-RSRP for the additional PCI with RTD>CP, introduce one or two more symbols for scheduling restriction.Proposal 3: For m-TRP sDCI dual TCI state switching, we think the delay should be cover the maximum of measurements for both two TCI states. No additional requirements if UE received PDSCH from single TRP.Proposal 4: For L1-RSRP for a cell with different PCI from serving cell, only SSB can be the measurement resource. The requirements should be only for SSB but no CSI-RS. |
| R4-2319362 | Huawei, HiSilicon | Observation 1: For RTD>CP in FR2, the promising scenario is for UE supporting multi-Rx at the same time.Observation 2: There is no constrains for UE supporting RTD>CP in FR1 compared with FR2.Proposal 1: Define requirements for UE supporting RTD>CP at least for FR1.Observation 3: For mTRP when RTD is less than CP, L1-RSRP in 9.5 and 9.13 can be reused.Proposal 2: For mTRP and RTD less than CP, L1-RSRP in 9.5 for serving cell and 9.13 for additionalPCI and TCI state switching requirements in 8.10 can be reused.Proposal 3: For mTRP mDCI and RTD less than CP, Rel-17 unified TCI state switching requirements are applicable for each TCI state associated with coresetPoolIndex independently. For FR2 when SSB are overlapped or adjacent, delay shall be extended that one additional SSB period is needed.Proposal 4: For mTRP mDCI when RTD is larger than CP in FR1, Rel-17 unified TCI state switching requirements are applicable for each TCI state associated with coresetPoolIndex independently.Proposal 5: For mTRP mDCI when RTD is larger than CP in FR1, L1-RSRP in 9.5 for serving cell and 9.13 for additionalPCI and TCI state switching requirements in 8.10 can be reused.Proposal 6: For sDCI MAC CE based TCI state switching case 2, R17 uTCI state requirements can apply for each uTCI state separately.  |
| R4-2319623 | MediaTek Inc. | Proposal 1: If UE cannot support simultaneous DL reception in FR2 and SSB resources are adjacent for sDCI mTRP, one more SSB period is needed in the TCI state switching delay requirement when dual TCI states are known. Proposal 2: If UE cannot support simultaneous DL reception in FR2 and SSB resources of dual TCI states are adjacent, longer TCI state switching delay is expected for case 2 and case 3.Proposal 3: For UEs with capability of supporting two TAs and RTD > CP, only consider two cells on a single frequency layer.Proposal 4: For UEs with capability of supporting two TAs and RTD > CP, reuse legacy L1-RSRP measurement period defined in R17 ICBM.Proposal 5: For UEs with capability of supporting two TAs and capable to support RTD > CP, RAN4 to consider one more symbol before and after the symbols configured for L1-RSRP measurement for scheduling restriction compared to legacy. Proposal 6: Not to define CSI-RS based L1-RSRP measurement requirement for mTRP in Rel-18 MIMO evo due to limited time. |
| R4-2320727 | Nokia, Nokia Shanghai Bell | Proposal 1: TCI state switches on both links are independent from each other, i.e., in the case of switching two TCI states simultaneously, the UE does not need to wait that both of them are finished to be able to start receiving/transmitting with each of them.Proposal 2: For multi DCI scenario in FR2, when both target TCI states are known or if one TCI state is known and one is unknown, MAC CE based switching and MAC CE active list update delay can be extended by 1 SSB period if SSB of both target TCI states are overlapped.Proposal 3: For multi DCI scenario in FR2, when both target TCI states are unknown, and L1-RSRP for both target TCI states is SSB based, MAC CE based switching and MAC CE active list update delay can be extended by 1 SSB period and 1 L1-RSRP period, if SSB of both target TCI states are overlapped.Observation 1: Even if a target TCI state is not in the active list of TCI states, additional TCI switching delay can be avoided by considering SSB of TCI states that are already active.Proposal 4: For multi DCI scenario, no T/F synchronization is needed if the target TCI state have QCL relationship with a RS of a TCI state in the active list of TCI states or if the target TCI state is in the active list of TCI states.Proposal 5: RAN4 to agree on a clear definition of what “adjacent SSBs” means, i.e. how long time is needed in between the SSBs so that the UE can synchronize with both.Proposal 6: Define the MAC-CE based TCI state switching and active TCI state list update delay clearly also in the case UE cannot synchronize with the SSB on the first occasion (i.e. when the SSBs are overlapping or “adjacent”). Additional SSB can be added in the TCI state switching delay in this case for m-DCI.Proposal 7: In mDCI scenario, TCI switching with one CORESETpoolindex does not cause interruptions on TCI states with another CORESETpoolindex.Proposal 8: In s-DCI, in the case UE cannot synchronize with both SSBs on the first occasion (i.e. when the SSBs are “adjacent”), additional SSB can be added in the MAC-CE based TCI state switching and active TCI state list update delay. Definition of adjacent is FFS.Proposal 9: For single DCI scenario, no T/F synchronization is needed if the target TCI state have QCL relationship with a RS of a TCI state in the active list of TCI states or if the target TCI state is in the active list of TCI states. |
| R4-2320781 | Ericsson | Proposal 1: For sDCI based mTRP for MAC CE based TCI state switching, when one of the TCI states to be switched is known and other is unknown, UE should receive data on known TCI state while switching unknown TCI state.Proposal 2: For sDCI based mTRP for MAC CE based TCI state switching, when two TCI state are unknown, UE is expected to receive data on new TCI states after both TCI state switch is completed.Proposal 3: For mDCI based mTRP, if UE supports RTD >CP and two TA, do not consider requirements without simultaneous reception. Proposal 4: For mDCI based mTRP, if UE do not support RTD >CP and if SSB of the TCI states are overlapping or adjacent, longer delay is expected or additional SSB burst is allowed. |

## Open issues summary

### Sub-topic 3-1:

[Backgroud] For sDCI, Case 1/Case 2 /Case 3, it is agreed

* Case1: If both target TCIs are known
* Case 2: If one of target TCIs is unknown and another is known
* Case 3: If both target TCIs are unknown

**Issue 3-1-1: For sDCI mTRP, how to specify DL MAC CE based dual TCI state switch the switching delay requirements for Case 1, if SSB are adjacent in FR2?**

* Proposals
	+ Proposal 1: (Apple)
		- THARQ + $3N\_{slot}^{subframe,µ}$ + max{TOk1\*(Tfirst-SSB1 +AD1\*TSSB1+ TSSB-proc), TOk2\*(Tfirst-SSB2 +AD2\*TSSB2+ TSSB-proc)} / NR slot length
			* AD1 = 1 if SSBs are adjacent in FR2 and TSSB1 ≤ TSSB2 ; 0 otherwise
			* AD2 = 1 if SSBs are adjacent in FR2 and TSSB2 < TSSB1 ; 0 otherwise
	+ Proposal 2: (MediaTek)
		- one more SSB period is needed in the TCI state switching delay requirement when dual TCI states are known
	+ Proposal 3: (Nokia)
		- additional SSB can be added in the MAC-CE based TCI state switching and active TCI state list update delay. Definition of adjacent is FFS.
		- no T/F synchronization is needed if the target TCI state have QCL relationship with a RS of a TCI state in the active list of TCI states or if the target TCI state is in the active list of TCI states.
* Recommended WF
	+ TBA

Moderator’s suggestion:

P1&P2&P3 are similar for extension one more SSB period. Check whether P1 can be agreeable.

sDCI is only for intra-cell. SSB periodicity should be the same. Check with companies.

**Issue 3-1-2: For sDCI mTRP, how to specify DL MAC CE based dual TCI state switch the switching delay requirements for Case 2, if SSB are adjacent in FR2?**

* Proposals
	+ Proposal 1: (Apple)
		- Case 2a: (TSSB1 ≤ TSSB2): THARQ + $3N\_{slot}^{subframe,µ}$ + TL1-RSRP1 +max{TOuk1\*(Tfirst-SSB1+ AD1\*TSSB1 + TSSB-proc), TOk2\*(Tfirst-SSB2 + TSSB-proc)} / *NR slot length*; AD1 = 1 if SSBs are adjacent in FR2 and TSSB1 ≤ TSSB2 ; 0 otherwise
		- Case 2b: (TSSB1 **>** TSSB2): THARQ + $3N\_{slot}^{subframe,µ}$ + max{TL1-RSRP1 + TOuk1\*(Tfirst-SSB1+ TSSB-proc), TOk2\*(Tfirst-SSB2 + TSSB-proc)} / *NR slot length;*
	+ Proposal 2: (MediaTek)
		- longer delay is expected
	+ Proposal 3: (Nokia)
		- additional SSB can be added in the MAC-CE based TCI state switching and active TCI state list update delay. Definition of adjacent is FFS.
		- no T/F synchronization is needed if the target TCI state have QCL relationship with a RS of a TCI state in the active list of TCI states or if the target TCI state is in the active list of TCI states.
* Recommended WF
	+ TBA

Moderator’s suggestion:

P1&P3 are similar for extension one more SSB period.

sDCI is only for intra-cell. SSB periodicity should be the same. Check with companies.

**Issue 3-1-3: For sDCI mTRP, how to specify DL MAC CE based dual TCI state switch the switching delay requirements for Case 3, if SSB are adjacent in FR2?**

* Proposals
	+ Proposal 1: (Apple, MediaTek)
		- longer delay is expected
	+ Proposal 2: (Nokia)
		- additional SSB can be added in the MAC-CE based TCI state switching and active TCI state list update delay. Definition of adjacent is FFS.
* Recommended WF
	+ TBA

**Issue 3-1-4: For sDCI mTRP, end point of dual TCI state switch delay requirements?**

* Proposals
	+ Proposal 1: (Apple, Samsung)
		- Dual TCI state switch requirements for sDCI are defined for the case when UE is expected to receive from both TCI states/ TRPs after the switch.
	+ Proposal 2: (Huwei)
		- For sDCI MAC CE based TCI state switching case 2, R17 uTCI state requirements can apply for each uTCI state separately.
	+ Proposal 3: (Nokia)
		- TCI state switches on both links are independent from each other, i.e., in the case of switching two TCI states simultaneously, the UE does not need to wait that both of them are finished to be able to start receiving/transmitting with each of them.
	+ Proposal 4: (Ericsson)
		- When one of the TCI states to be switched is known and other is unknown, UE should receive data on known TCI state while switching unknown TCI state.
		- When two TCI state are unknown, UE is expected to receive data on new TCI states after both TCI state switch is completed.

**Issue 3-1-5 For sDCI mTRP, active TCI state list update delay**

* Proposals
	+ Proposal 1 (Nokia)
		- additional SSB can be added in the MAC-CE based TCI state switching and active TCI state list update delay. Definition of adjacent is FFS.

**Issue 3-1-6 For sDCI mTRP, when RTD>CP, how to specify DL TCI state switching requirements?**

* Proposals
	+ Proposal 1 (Xiaomi)
		- If RTD>CP, for sDCI, when two SSBs are overlapped or adjacent, one more SSB for TCI activation is needed.

Moderator’s: RTD>CP capability is only for mDCI. No sDCI. Check with companies.

**Issue 3-1-7-a For mDCI mTRP, how to specify DL TCI state switching requirements for eUTCI if UE not supporting two TAs?**

[agreements in previous meeting: Rel-17 unified TCI state switching requirements are applicable for each TCI state associated with coresetPoolIndex independently]

* Proposals
	+ Proposal 1 (Apple)
		- Same as legacy per TRP, with extension for overlapping/adjacent SSB in FR2
		- [Known]: THARQ + $3N\_{slot}^{subframe,µ}$+ TOk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB
		- [Unknown]: THARQ + $3N\_{slot}^{subframe,µ}$+ TL1-RSRP + TOuk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB
		- OL=1 if SSB overlaps or adjacent to SSB from other TRP in FR2 and SSB periodicity is less than that of other TRP, 0 otherwise
	+ Proposal 2 (Huawei)
		- L1-RSRP in 9.5 for serving cell and 9.13 for additionalPCI and TCI state switching requirements in 8.10 can be reused.
		- For FR2 when SSB are overlapped or adjacent, delay shall be extended that one additional SSB period is needed.
	+ Proposal 3 (Nokia)
		- For FR2, if SSB of both target TCI states are overlapped, one SSB period can be extended.
		- no T/F synchronization is needed if the target TCI state have QCL relationship with a RS of a TCI state in the active list of TCI states or if the target TCI state is in the active list of TCI states.
		- Add definition of “adjacent SSB”

Moderator’s suggestion:

P1&P2&P3 are similar for extension one more SSB period. Check whether P1 can be agreeable

**Issue 3-1-7-b For mDCI mTRP, how to specify UL TCI state switching requirements for eUTCI if UE not supporting two TAs?**

[agreements in previous meeting: Rel-17 unified TCI state switching requirements are applicable for each TCI state associated with coresetPoolIndex independently]

* Proposals
	+ Proposal 1 (Apple)
		- UL TCI state switch: Same as legacy per TRP
* Recommended WF
	+ Keep previous agreement to reuse

**Issue 3-1-8-a: For mDCI mTRP, how to specify DL TCI state switching requirements for eUTCI if UE supporting two TAs and but not supporting RTD>CP?**

* Proposals
	+ Proposal 1 (Apple)
		- Same as legacy per TRP, with extension for overlapping/adjacent SSB in FR2
		- [Known]: THARQ + $3N\_{slot}^{subframe,µ}$+ TOk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB
		- [Unknown]: THARQ + $3N\_{slot}^{subframe,µ}$+ TL1-RSRP + TOuk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB
		- OL=1 if SSB overlaps or adjacent to SSB from other TRP in FR2 and SSB periodicity is less than that of other TRP, 0 otherwise
	+ Proposal 2 (Huawei)
		- L1-RSRP in 9.5 for serving cell and 9.13 for additionalPCI and TCI state switching requirements in 8.10 can be reused.
		- For FR2 when SSB are overlapped or adjacent, delay shall be extended that one additional SSB period is needed.

Moderator’s suggestion:

P1&P2 are similar for extension one more SSB period. Check whether P1 can be agreeable

**Issue 3-1-8-b: For mDCI mTRP, how to specify UL TCI state switching requirements for eUTCI if UE supporting two TAs and but not supporting RTD>CP?**

* Proposals
	+ Proposal 1 (Apple)
		- [Known case] THARQ + $3N\_{slot}^{subframe,µ}$ + TOk-ref (Tfirst-SSB-DLRef + 2ms)+NM\*( Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms)
		- [Unknown case]: THARQ + $3N\_{slot}^{subframe,µ}$ + TL1-RSRP + TOuk-ref (Tfirst-SSB-DLRef + 2ms)+ Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms

**Issue 3-1-9-a: For mDCI mTRP, how to specify DL TCI state switching requirements for eUTCI if UE supporting two TAs and supporting RTD>CP?**

* Proposals
	+ Proposal 1 (Apple)
		- Same as legacy per TRP, with extension for overlapping/adjacent SSB in FR2
		- [Known]: THARQ + $3N\_{slot}^{subframe,µ}$+ TOk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB
		- [Unknown]: THARQ + $3N\_{slot}^{subframe,µ}$+ TL1-RSRP + TOuk\*(Tfirst-SSB + TSSB-proc) + OL\*TSSB
		- OL=1 if SSB overlaps or adjacent to SSB from other TRP in FR2 and SSB periodicity is less than that of other TRP, 0 otherwise
	+ Proposal 2 (Huawei)
		- Only for FR1, Reuse Rel-17 requirements
	+ Proposal 3 (Ericsson)
		- Not support. Do not define requirements.

**Issue 3-1-9-b: For mDCI mTRP, how to specify UL TCI state switching requirements for eUTCI if UE supporting two TAs and supporting RTD>CP?**

* Proposals
	+ Proposal 1 (Apple)
		- [Known case] THARQ + $3N\_{slot}^{subframe,µ}$ + TOk-ref (Tfirst-SSB-DLRef + 2ms)+NM\*( Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms)
		- [Unknown case]: THARQ + $3N\_{slot}^{subframe,µ}$ + TL1-RSRP + TOuk-ref (Tfirst-SSB-DLRef + 2ms)+ Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms
	+ Proposal 2 (Huawei)
		- Only for FR1
	+ Proposal 3 (Ericsson)
		- Not support. Do not define requirements.

**Issue 3-1-10 For mDCI mTRP, active TCI state list update delay**

* Proposals
	+ Proposal 1 (Nokia)
		- additional SSB can be added in the MAC-CE based TCI state switching and active TCI state list update delay. Definition of adjacent is FFS.

**Issue 3-1-11: L1-RSRP measurement when RTD>CP**

* Proposals
	+ Proposal 1 (Xiaomi)
		- UE capable of RTD>CP
			* if UE support *simultaneousRxDataSSB-DiffNumerology* capability, UE can perform measurement without restriction and doesn’t need RTD>CP capability.
			* if UE not support *simultaneousRxDataSSB-DiffNumerology* capability, RAN4 to discuss whether UE can process
		- UE incapable of RTD>CP in FR1
			* measurement period for SSB based measurement from serving cell and cell with different PCI will be scaled by 2 when overlapped. The confliction case will include SSB based measurement for L1-RSRP/BFD/CBD/RLM.
			* define measurement restriction when SSB from cell with different PCI is overlapped with CSI-RS from serving cell.
	+ Proposal 2 (Samsung)
		- For inter-cell, update the applicability of timing depends on UE capability. Reuse Rel-17 ICBM sharing for SSBs are overlapping or adjacent. Introduce one or two more symbols for scheduling restriction. All other requirements in Rel-17 can be reused.
		- For intra-cell scenario, RTD>CP case, reuse similar Rel-17 ICBM sharing for SSBs are overlapping or adjacent by sharing factor of 2. Introduce one or two more symbols for scheduling restriction.
	+ Proposal 2 (MediaTek)
		- Reuse Rel-17 ICBM L1-RSRP
		- one more symbol before and after the symbols configured for L1-RSRP measurement for scheduling restriction compared to legacy.

**Issue 3-1-12: L1-RSRP measurement for resource type of mTRP**

* Proposals
	+ Proposal 1 (Samsung, MediaTek)
		- SSB only, no CSI-RS

# Topic #4: Draft CRs for core part

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2319056 | vivo | Draft CR on L1-RSRP RRM requirements in R18 NR MIMO evolutionClauses affected: 9.5.2 |
| R4-2320780 | Ericsson | Draft CR on TDCP requirementsClauses affected: new 9.X |
| R4-2318616 | Apple | Draft CR on MRTD requirementsClauses affected: 7.6.1 new 7.6.x |
| R4-2319637 | Ericsson | Draft CR on UL Transmit timing for MIMO EvolutionClauses affected: 7.1.1&7.1.2 |
| R4-2319967 | Huawei, HiSilicon | DraftCR on MTTD requirements for UL multi-DCI multi-TRP with two TAsClauses affected: new 7.5.7 |
| R4-2318585 | Apple | Draft CR on UL TCI state switching delay requirements for eUTCI for mDCIClauses affected: new 8.X4 |
| R4-2318853 | xiaomi | DraftCR on L1-RSRP measurement for cell with different PCI when actual timing offset can be larger than CPClauses affected: 9.13 |
| R4-2319219 | Samsung | Draft CR on active downlink TCI state switching delay for unified TCI for sDCI mTRPClauses affected: new 8.X1 |
| R4-2319363 | Huawei, HiSilicon | Draft CR on Active uplink TCI state switching delay for unified TCI for sDCI mTRPClauses affected: new 8.X3 |
| R4-2320728 | Nokia, Nokia Shanghai Bell | Draft CR for Active downlink TCI state switching delay for unified TCI for mDCI mTRPClauses affected: new 8.X2 |

Moderator’s suggestion: Collect the comments for CRs in the meeting.

# Topic #5: Performance part

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318586 | Apple | Observation #1: For mDCI the R17 UTCI state requirements are applicable per TRP independently with association of coresetPoolIndex.Observation #2: Nothing new will be tested in terms of UTCI state switch in the context of mDCI scheme.Proposal #1: Do not introduce performance test cases for eUTCI for mDCI mTRP transmission scheme. Observation #3: For sDCI with single TCI state switch no new requirements are defined and the R17 UTCI state requirements are reused.Proposal #2: Do not introduce performance test cases for eUTCI for sDCI mTRP transmission scheme with single TCI state switch. Proposal #3: RAN4 further discuss performance test cases for sDCI mTRP with dual TCI state switch. Proposal #4: Introduce the following test cases in FR2 for MAC CE based sDCI dual TCI state switch. (1) Separate TCI state switch on DL, with sDCI TDM transmission scheme(2) Separate UL TCI state switch, with PUSCH repetition |
| R4-2319218 | Samsung | Proposal 1: By the conclusion of feasibility study, if RAN4 to agree introduce TDCP accuracy reequipments for amplitude reporting, new measurement accuracy requirement of TDCP should be specified. Otherwise, no measurement accuracy requirements for TDCP.Proposal 2: It is proposed to add test cases as below table:

|  |  |
| --- | --- |
| Test purpose | Test cases |
| [TDCP accuracy test] | * Depends on the conclusion of TDCP
 |
| Interruptions at SRS antenna port switching | * No new test case.
 |
| Uplink transmit timing for two cells to support two TA | * NR SA in FR1
* NR SA in FR2
 |
| m-TRP MAC-CE based TCI state switch delay | TC-x: NR FR2, intra-cell (Serving cell ) sDCI + DL TCI + dual TCI state switching + one is known; one is unknownTC-x: NR FR2, intra-cell (Serving cell ) sDCI + UL TCI + dual TCI state switching + both two are knownTC-x: NR FR2, intra-cell (Serving cell ) sDCI + DL TCI + dual TCI state switching + two are unknownTC-x: NR FR2, inter-cell mDCI + DL TCI + both two are known, RTD<CPTC-x: NR FR2, inter-cell mDCI + UL TCI + both two are known, RTD>CP* If no test concern from companies, RAN4 can add test cases for both NR and EN-DC.
 |

 |
| R4-2319968 | Huawei, HiSilicon | Proposal 2: It is suggested to introduce the TDCP measurements reporting mapping table in TS38.133 which can be defined as Table 2.Table 2: Quantization of amplitude value for TDCP reporting

|  |  |
| --- | --- |
| Value of $q$ | TDCP Range |
| 0 | $1-2^{-\left(16-1\right)/2}$ ~$ 1$ | 0.9945< TDCP <=1 |
| 1 | $1-2^{-\left(16-2\right)/2} $ ~ $1-2^{-\left(16-1\right)/2}$ | 0.9922< TDCP <=0.9945 |
| 2 | $1-2^{-\left(16-3\right)/2} $ ~ $1-2^{-\left(16-2\right)/2}$ | 0.9890< TDCP <=0.9922 |
| 3 | $1-2^{-\left(16-4\right)/2} $ ~ $1-2^{-\left(16-3\right)/2}$ | 0.9844< TDCP <=0.9890 |
| … | … | … |
| 12 | $1-2^{-\left(16-13\right)/2} $ ~ $1-2^{-\left(16-12\right)/2}$ | 0.6464< TDCP <=0.75 |
| 13 | $1-2^{-\left(16-14\right)/2}$ ~ $1-2^{-\left(16-13\right)/2}$ | 0.5< TDCP <=0.6464 |
| 14 | $1-2^{-\left(16-15\right)/2}$ ~ $1-2^{-\left(16-14\right)/2}$ | 0.2929< TDCP <=0.5 |
| 15 | $1-2^{-\left(16-16\right)/2}$ ~ $1-2^{-\left(16-15\right)/2}$ | 0< TDCP <=0.2929 |

Proposal 3: New timing advance adjustment test is suggested to be introduced for verifying UE capability of supporting two TAs.Proposal 4: Define test case for uTCI extension to mTRP for FR2 non-simultaneous DL/UL.Proposal 5: RAN4 to define test cases for uTCI extension to mTRP based on Table I.Table I. Test case for uTCI extension to mTRP

|  |  |
| --- | --- |
| sDCI | sDCI FR2 MAC-CE based active joint TCI state switch for a known TCI state |
| sDCI FR2 MAC-CE based active DL TCI state switch for a known TCI state |
| sDCI FR2 MAC-CE based active UL TCI state switch for a known TCI state |
| mDCI | mDCI FR2 MAC-CE based active joint TCI state switch for a known TCI state |
| mDCI FR2 MAC-CE based active DL TCI state switch for a known TCI state |
| mDCI FR2 MAC-CE based active UL TCI state switch for a known TCI state |
| mDCI FR2 MAC-CE based active joint TCI state switch for a known TCI state with RTD larger than CP |
| mDCI FR2 MAC-CE based active DL TCI state switch for a known TCI state with RTD larger than CP |
| mDCI FR2 MAC-CE based active UL TCI state switch for a known TCI state with RTD larger than CP |

 |
| R4-2320730 | Nokia, Nokia Shanghai Bell | Proposal 1: Define the test case for the two TA feature including:- A setup with two TRPs, each sending its own TA command;- An adjustable timing delay between the two cells/TRPs to verify MRTD and MTTD requirements.Proposal 2: Define the test case for the two TA feature including two MRTD configurations, assuming either MRTD > CP or MRTD = CP; a UE will only run one of the two configurations depending on whether it supports MRTD > CP or MRTD = CP.Proposal 3: Define the test case for the unified TCI state switching for mTRP including at least sDCI FR2 MAC-CE based TCI switch for:- Case 1: Both target TCIs are known;- Case 2: One of target TCIs is unknown and another is known;- Case 3: Both target TCIs are unknown.Proposal 4: Wait for the conclusions of feasibility study about TDCP in Topic #2 before defining any test case. |
| R4-2320782 | Ericsson | Proposal 1: If the TDCP accuracy test cases are found feasible, RAN4 to define TDCP accuracy requirements.Proposal 2: For a UE supporting two TA, Ran4 to define following tests.• UE Transmit Timing Test in FR1 • UE Transmit Timing Test in FR2• Timing advance adjustment accuracy for FR1 • Timing advance adjustment accuracy for FR2Proposal 3: In sDCI scenario, MAC CE based unified TCI state switching should be tested fora. joint TCI state switching b. Separate DL TCI state switchc. Separate UL TCI state switch |

## Open issues summary

### Sub-topic 5-1: Measurement accuracy

**Issue 5-1-1: TDCP measurement accuracy**

Moderator’ suggestion:

* Continue the discussion in topic 1. When there is conclusion for feasibility study, this issue can be discussed.

**Issue 5-1-2: TDCP Measurement Report Mapping**

* Proposals
	+ Proposal 1: (Huawei)
		- Add the below table for amplitude reporting in 38.133
* **Table: Quantization of amplitude value for TDCP reporting**

|  |  |
| --- | --- |
| **Value of** $q$ | **TDCP Range** |
| 0 | $1-2^{-\left(16-1\right)/2}$ ~$ 1$ | 0.9945< TDCP <=1 |
| 1 | $1-2^{-\left(16-2\right)/2} $ ~ $1-2^{-\left(16-1\right)/2}$ | 0.9922< TDCP <=0.9945 |
| 2 | $1-2^{-\left(16-3\right)/2} $ ~ $1-2^{-\left(16-2\right)/2}$ | 0.9890< TDCP <=0.9922 |
| 3 | $1-2^{-\left(16-4\right)/2} $ ~ $1-2^{-\left(16-3\right)/2}$ | 0.9844< TDCP <=0.9890 |
| … | … | … |
| 12 | $1-2^{-\left(16-13\right)/2} $ ~ $1-2^{-\left(16-12\right)/2}$ | 0.6464< TDCP <=0.75 |
| 13 | $1-2^{-\left(16-14\right)/2}$ ~ $1-2^{-\left(16-13\right)/2}$ | 0.5< TDCP <=0.6464 |
| 14 | $1-2^{-\left(16-15\right)/2}$ ~ $1-2^{-\left(16-14\right)/2}$ | 0.2929< TDCP <=0.5 |
| 15 | $1-2^{-\left(16-16\right)/2}$ ~ $1-2^{-\left(16-15\right)/2}$ | 0< TDCP <=0.2929 |

* Recommended WF
	+ Agree to capture the amplitude reporting table in 38.133. Check the values in the table.

### Sub-topic 5-2: Test cases

**Issue 5-2-1: Whether to define TCs for two TAs?**

* Proposals
	+ Proposal 1: (Samsung, Huawei, Nokia, Ericsson)
		- Yes

|  |  |
| --- | --- |
| Samsung | Uplink transmit timing for two cells to support two TA – NR SA in FR1Uplink transmit timing for two cells to support two TA – NR SA in FR2 |
| Huawei | New timing advance adjustment test |
| Nokia | 1. Test case for the two TA feature including:

- A setup with two TRPs, each sending its own TA command;- An adjustable timing delay between the two cells/TRPs to verify MRTD and MTTD requirements.1. Test case for the two TA feature including two MRTD configurations, assuming either MRTD > CP or MRTD = CP; a UE will only run one of the two configurations depending on whether it supports MRTD > CP or MRTD = CP.
 |
| Ericsson | • UE Transmit Timing Test in FR1 • UE Transmit Timing Test in FR2• Timing advance adjustment accuracy for FR1 • Timing advance adjustment accuracy for FR2 |

* Recommended WF
	+ TBA

**Issue 5-2-2: Whether to define TCs for m-DCI mTRP cases?**

* + Proposal 1: (Samsung, Huawei)
		- Yes

|  |  |
| --- | --- |
| Samsung | m-TRP MAC-CE based TCI state switch delay* TC-x: NR FR2, inter-cell mDCI + DL TCI + both two are known, RTD<CP
* TC-x: NR FR2, inter-cell mDCI + UL TCI + both two are known, RTD>CP
 |
| Huawei | * mDCI FR2 MAC-CE based active joint TCI state switch for a known TCI state
* mDCI FR2 MAC-CE based active DL TCI state switch for a known TCI state
* mDCI FR2 MAC-CE based active UL TCI state switch for a known TCI state
* mDCI FR2 MAC-CE based active joint TCI state switch for a known TCI state with RTD larger than CP
* mDCI FR2 MAC-CE based active DL TCI state switch for a known TCI state with RTD larger than CP
* mDCI FR2 MAC-CE based active UL TCI state switch for a known TCI state with RTD larger than CP
 |

* + Proposal 2: (Apple)
		- No
* Recommended WF
	+ TBA

**Issue 5-2-2: Whether to define TCs for s-DCI mTRP cases?**

* + Proposal 1: (Apple, Samsung, Huawei, Nokia, Ericsson)
		- Yes

|  |  |
| --- | --- |
| Apple | * No TC for eUTCI for sDCI mTRP with single TCI state switch
* TCs for eUTCI for sDCI mTRP with dual TCI state switch in FR2
	+ Separate TCI state switch on DL, with sDCI TDM transmission scheme
	+ Separate UL TCI state switch, with PUSCH repetition
 |
| Samsung | m-TRP MAC-CE based TCI state switch delay* TC-x: NR FR2, intra-cell (Serving cell ) sDCI + DL TCI + dual TCI state switching + one is known; one is unknown
* TC-x: NR FR2, intra-cell (Serving cell ) sDCI + UL TCI + dual TCI state switching + both two are known
* TC-x: NR FR2, intra-cell (Serving cell ) sDCI + DL TCI + dual TCI state switching + two are unknown
 |
| Huawei | * sDCI FR2 MAC-CE based active joint TCI state switch for a known TCI state
* sDCI FR2 MAC-CE based active DL TCI state switch for a known TCI state
* sDCI FR2 MAC-CE based active UL TCI state switch for a known TCI state
 |
| Nokia | Dual TCI state switching:* Case 1: Both target TCIs are known;
* Case 2: One of target TCIs is unknown and another is known;
* Case 3: Both target TCIs are unknown.
 |
| Ericsson | MAC CE based unified TCI state switching should be tested for* joint TCI state switching
* Separate DL TCI state switch
* Separate UL TCI state switch
 |

* Recommended WF
	+ Define several test cases for sDCI m-TRP MAC-CE based TCI state switch delay
	+ Agree all test cases are based on dual TCI state switching.
	+ FFS on:
		- Test cases are all for FR2?
		- Including:
			* Joint TCI state switching
			* Separate DL TCI state switch
			* Separate UL TCI state switch
		- Whether the two states are known or unknown?