**3GPP TSG RAN Meeting #89e RP-201469**

**Electronic Meeting, September 14-18, 2020**

## Status Report to TSG

**Agenda item:** 9.8.1

|  |  |
| --- | --- |
| **WI / SI Name** | Further Enhancements on MIMO for NR |
| included in this status report | Study Item: No | Core part: Yes | Performance part:Yes | Testing part:No |
| **Acronym** | NR\_FeMIMO |
| **Unique ID** | 860040 |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-193133 |
| **Target Completion Date****(indicate if changed)** | Study Item: n/a | Core part: 09/2021 | Performance part: 03/2022 | Testing part: n/a |
| **Overall Completion level** | Study Item: n/a | Core part: 10% | Performance Part: 0% | Testing part: n/a |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |
| --- | --- |
| **Leading WG** | RAN1 |
| **Rapporteur** | **Name** | Eko Onggosanusi |
| **Company** | Samsung |
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## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.
 One time unit (TU) corresponds to ~ 2 hours in the meeting.
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

 NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

**In RAN1#102-e, the following agreements were made**:

Multi-beam enhancements:

**Agreement**

The three proposals on R1-2007151 on the evaluation methodology for multi-beam enhancement are agreed.

**Agreement**

**Note**: the enumeration for issues (such as “issue 1a), 1b), 6) in the proposal below refers to the enumeration within the proposals, not Table 1 in the FL summary.

* [Issue 1] For Rel.17 NR FeMIMO, on the unified TCI framework
	1. Support joint TCI for DL and UL based on and analogous to Rel.15/16 DL TCI framework
		+ The term “TCI” at least comprises a TCI state that includes at least one source RS to provide a reference (UE assumption) for determining QCL and/or spatial filter
		+ The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC
			- FFS: Optionally this common QCL information can also apply to CSI-RS resource for CSI, CSI-RS resource for BM, and CSI-RS for tracking
			- FFS: Applicability on PDSCH includes PDSCH default beam
			- Working Assumption: Select between M=1 and M>=1
		+ The source reference signal(s) in N TCIs provide a reference for determining common UL TX spatial filter(s) at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC,
			- Optionally, this UL TX spatial filter can also apply to all SRS resources in resource set(s) configured for antenna switching/codebook-based/non-codebook-based UL transmissions
			- FFS: applicability of this UL TX spatial filter to SRS configured for beam management (BM)
			- FFS: PUSCH port determination based on the TCI, e.g., to be mapped with SRS ports analogous to Rel.15/16
			- Working Assumption: Select between N=1 and N>=1
		+ FFS: extension to common QCL information applied to only some of the CORESETs or PUCCH resources in a CC, e.g. for mTRP
		+ FFS: When used for the purpose of joint beam indication for UL and DL, whether a joint TCI pool for DL and UL dedicated for the purpose is used, or the same TCI pool as that used for the purpose of separate DL/UL beam indication is used
		+ Note: The resulting beam indication directly refers to the associated source RS(s)
		+ FFS (RAN1#103-e): Details on extension to intra- and inter-band CA
		+ FFS (RAN1#103-e): The supported number of active TCI states considering factors such as multi-TRP and issue 6
		+ FFS (RAN1#103-e): Applicable QCL types, and co-existence with DL TCI and spatial relation indication in Rel.15/16
	2. In RAN1#103-e, investigate, for the purpose of down selection, the following alternatives for accommodating the case of separate beam indication for UL and DL
		+ Alt1. Utilize the joint TCI to include references for both DL and UL beams
		+ Alt2. Utilize two separate TCI states, one for DL and one for UL. The TCI state for the DL is the same as agreed in 1a. The TCI state for the UL can be newly introduced.
			- Alt 2-1: The UL TCI state is taken from the same pool of TCI states as the DL TCI state
			- Alt 2-2: The UL TCI state is taken from another pool of TCI states than the DL TCI state
		+ Note: The resulting beam indication directly refers to the associated source RS(s)
		+ FFS (RAN1#103-e): Details on extension to intra- and inter-band CA
		+ Note: This may be related to issue 5 as well as other reasons for different TCIs such as network flexibility/scheduling
	3. Support the use of SSB/CSI-RS for BM and/or SRS for BM as source RS to determine a UL TX spatial filter in the unified TCI framework
		+ Whether the UL TX spatial filter corresponds to UL TCI (separate from DL TCI) depends on the outcome of 1b) above
		+ FFS: Support the use of non-BM CSI-RS and/or non-BM SRS in addition
	4. In RAN1#103-e, decide if SRS for BM can be configured as a source RS to represent a DL RX spatial filter in the unified TCI framework
	5. In RAN1#103-e, decide/finalize all other parameters included in or concurrent with (but not included in) the TCI, e.g. UL-PC-related parameters (involving P0/alpha, PL RS, and/or closed loop index), UL-timing-related parameters
	6. In RAN1#103-e, identify issues pertaining to alignment between DL and UL default beam assumptions using the unified TCI framework
* [Issue 2] For Rel.17 NR FeMIMO, on L1/L2-centric inter-cell mobility:
	1. In RAN1#103-e, finalize scope and use cases for L1/L2-centric inter-cell mobility, including:
		+ Applicability in various non-CA and CA setups such as intra-band and inter-band CA
		+ Use cases in comparison to Rel.15 L3-based handover (HO) taking into account potential extension of DAPS-based Rel.16 mobility enhancement to FR2-FR2 HO
		+ The extent of RAN2 impact (MAC CE, RRC, user plane protocols)
		+ Network architecture, e.g. NSA vs. SA, inter-RAT scenarios
	2. In RAN1#103-e, depending on the outcome of 2a), further identify additional components –along with the associated alternatives –required for supporting inter-cell mobility based on the same unified TCI framework as that for intra-cell mobility (including dynamic TCI state update signaling), including
		+ Method(s) for incorporating non-serving cell information associated with TCI
		+ Method(s) for DL measurements and UE reporting (e.g. L1-RSRP) associated with non-serving cell(s)
		+ UE behavior for reception of signals and non-UE-specific control and data channels associated with non-serving cell(s)
		+ UL-related enhancements, e.g. related to RA procedure including TA
		+ Beam-level event-driven mechanism for L1/L2-centric inter-cell mobility
* [Issue 3] For Rel.17 NR FeMIMO, on dynamic TCI state update signaling medium:
	1. In RAN1#103-e, investigate, for the purpose of down selection, the following alternatives:
		+ Alt1. DCI
		+ Alt2. MAC CE
		+ Note: Combination between DCI and MAC CE for, e.g. different use cases or control information partitioning can also be considered
		+ Note: The study should consider factors such as feasibility for pertinent use cases, performance (based on at least the agreed EVM), overhead (including PDCCH capacity), latency, flexibility, reliability including the support of retransmission
		+ Note: This may be related to outcome of issue 1a), 1b), and 6a)
	2. In RAN1#103-e, depending on the outcome of 3a), identify candidates for more detailed design issues for the dynamic TCI state update such as
		+ Exact content
		+ Signaling format
		+ Reliability aspects including the support of retransmission
		+ Extensions, including the support of UE-group (in contrast to UE-dedicated) signaling
* [Issue 4] For Rel.17 NR FeMIMO, on MP-UE assumption to facilitate fast UL panel selection:
	1. The following assumptions are used:
		+ In terms of RF functionality, a UE panel comprises a collection of TXRUs that is able to generate one analog beam (one beam may correspond to two antenna ports if dual-polarized array is used)
		+ UE panels can constitute the same as well as different number of antenna ports, number of beams, and EIRP
		+ No beam correspondence across different UE panels
		+ FFS: For each UE panel, it can comprise an independent unit of PC, FFT timing window, and/or TA.
		+ FFS: Same or different sets of UE panels can be used for DL reception and UL transmission, respectively
	2. In RAN1#103-e, identify candidate use cases including MPE, and consider remaining aspects if use cases are identified
	3. In RAN1#103-e, identify candidate signaling schemes for the following:
		+ NW to MP-UE (taking into account potential extension of the unified TCI framework in issue 1)
		+ MP-UE to NW
* [Issue 5] For Rel.17 NR FeMIMO, on MPE mitigation (that is, minimizing the UL coverage loss due to the UE having to meet the MPE regulation), in RAN1#103-e:
	1. If needed, identify candidate solutions to be down-selected in future meeting(s). The following sub-categories can be used:
		+ CAT0. The need for specification support for MPE event detection and, if needed, candidate solutions
		+ CAT1. The need for UE reporting associated with an MPE and/or a potential/anticipated MPE event if the UE selects a certain UL spatial resource, e.g., corresponding to DL or UL RS
		+ CAT2. The need for NW signaling in response to the reported MPE event (taking into account issue 1) and UE behavior after receiving the NW signaling
		+ Note: RAN4 has agreed to specify P-MPR reporting (cf. CRs for TS 38.101/102/133) which can be used as a baseline scheme for further enhancement
		+ Note: This may be related to outcome of issue 4b)
	2. Companies are encouraged to submit evaluation results based on the agreed EVM to justify the benefits of the candidate solutions
* [Issue 6] For Rel.17 NR FeMIMO,
	1. add another category on performing study and, if needed, specifying feature(s) for beam acquisition (including beam tracking and refinement) latency reduction, especially for scenarios with high-speed UEs and large number of configured TCI states
	2. Partial BFR will be handled in ITEM 2c (BM enhancement for mTRP)

Note: The target “RAN1#103-e” is understood as best-effort, i.e. to finalize as many components as possible based on the status of companies’ contributions.

Multi-TRP enhancements for PDCCH, PUSCH, and pUCCH:

**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 PDCCHOption 2: Spec transparent SFNFor FR1: Both options 1 and 2 can be consideredFor 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

**Agreement**

* Detailed assumptions for PUCCH evaluation:

|  |  |
| --- | --- |
| Parameters | Potential values |
| Baseline scheme | Rel-15 PUCCH repetition |
| PUCCH format | Format 1 and 3. Other PUCCH Formats can be optionally considered.  |
| # of RBs/symbols | PUCCH Format 1: 4 symbols, 1 RBPUCCH Format 3: 4 and 8 symbols, 1 RBOther combinations are not precluded.  |
| UCI payload  | 2 bits for PUCCH Format 1 (and Format 0, if considered). Companies to report assumptions on other PUCCH Formats  |
| Frequency hopping | Reported by companies |
| Number of repetitions (when applicable) | 2, 4, 8 |
| Schemes | TDMDetails to be reported by companies |
| Receiver assumption | Reported by companies |

* Detailed assumptions for PUSCH evaluation:

|  |  |
| --- | --- |
| Parameters | Potential values |
| Baseline scheme | Rel-15/-16 PUSCH repetition |
| # of RBs/symbols | Companies to Report.  |
| DMRS pattern | DM-RS configuration type 1DM-RS Configuration type 2 (optional) |
| # of layers | 1, 2 (optional)  |
| Code rates | Low (<0.2) and moderate (<0.4) |
| Frequency hopping | Reported by companies |
| UL transmission scheme | Codebook based UL transmission is baseline. Non-codebook based can be optional. |
| Redundancy Version | Reported by companies |
| Number of repetitions (when applicable) | 2, 4, 8 Other numbers are not precluded |
| Schemes | TDMDetails to be reported by companies |
| Receiver assumption | Reported by companies |

**Agreement**

To improve reliability and robustness for PUCCH using multi-TRP and/or multi-panel, consider all PUCCH formats.

**Agreement**

To enable TDMed PUCCH transmission with different beams, support configuring/activating of multiple PUCCH Spatial Relation Info. RAN1 shall further study the exact schemes considering the following aspects,

* Method of configuration/activation of multiple spatial relation info
* Use of the same PUCCH resource or different PUCCH resource for PUCCH transmission
* Mapping between PUCCH repetition/symbol and spatial relation info among multiple PUCCH repetitions / multiple PUCCH symbols.

**Agreement**

For configuration/indication of the number of PUCCH repetitions, RAN1 shall further study the following,

* Alt.1: Use Rel-15 like framework
* Alt.2: Dynamic indication of the number of PUCCH repetitions

**Agreement**

For multi-TRP PUCCH transmission, further investigate required power control enhancement.

**Agreement**

Further study M-TRP CG PUSCH reliability enhancements in Rel-17.

**Agreement**

Support TDMed PUCCH scheme(s) to improve reliability and robustness for PUCCH using multi-TRP and/or multi-panel. Study the following alternatives,

* Alt.1: supporting both inter-slot repetition and intra-slot repetition / intra-slot beam hopping.
* Alt.2: supporting only inter-slot repetition
* Note1: It is not precluded to study the use of multiple PUCCH resources to repeat the same UCI in both inter-slot repetition and intra-slot repetition.
* Note2: The alternatives are clarified as below,
	+ inter-slot repetition: One PUCCH resource carries UCI , another one or more PUCCH resources or the same PUCCH resource in another one or more slots carries a repetition of the UCI .
	+ intra-slot repetition: One PUCCH resource carries UCI , another one or more PUCCH resources or the same PUCCH resource in another one or more sub-slots carries a repetition of the UCI
	+ intra-slot beam hopping: UCI is transmitted in one PUCCH resource in which different sets of symbols have different beams

**Agreement**

For M-TRP PUSCH reliability enhancement, support single DCI based PUSCH transmission/repetition scheme(s).

* Further study multi-DCI based PUSCH transmission/repetition scheme(s) to identify potential gains and required enhancements.
* Note: This agreement does not reflect any prioritization of single DCI based PUSCH transmission/repetition over multi-DCI based PUSCH transmission/repetition. Ran1 can further discuss that in the next meeting.

**Agreement**

For single DCI based M-TRP PUSCH reliability enhancement, support TDMed PUSCH repetition scheme(s) based on Rel-16 PUSCH repetition Type A and Type B.

* Further study PUSCH transmission without repetition as a potential candidate M-TRP PUSCH scheme

**Agreement**

To support single DCI based M-TRP PUSCH repetition scheme(s), up to two beams are supported. RAN1 shall further study the details considering,

1. Codebook based and non-codebook based PUSCH
2. Enhancements on SRI/TPMI/power control parameters/any other

Note1: Companies are encouraged to provide additional details on how above enhancements are applied to different PUSCH repetitions (e.g. mapping between PUSCH repetitions and beams)

Note2: Studying enhancements/aspects related to TA is not precluded.

**Agreement**

On the mapping between PUSCH repetitions and beams in single DCI based multi-TRP PUSCH repetition Type A and Type B, further study the following,

* For both PUSCH repetition Type A and B, how the beams are mapped to different PUSCH repetitions (or slots/frequency hops),
	+ Alt.1: cyclical mapping pattern (the first and second beam are applied to the first and second PUSCH repetition, respectively, and the same beam mapping pattern continues to the remaining PUSCH repetitions).
	+ Alt.2: sequential mapping pattern (the first beam is applied to the first and second PUSCH repetitions, and the second beam is applied to the third and fourth PUSCH repetitions, and the same beam mapping pattern continues to the remaining PUSCH repetitions).
	+ Alt.3: Half-Half pattern (the first beam is applied to the first half of PUSCH repetitions, and the second beam is applied to the second half of PUSCH repetitions)
	+ Alt.~~3~~4: Other variants (e.g. configurable mapping patterns)
	+ Note1: For PUSCH repetition type B, the variants considering slot level beam mapping with the same mapping principals (replacing repetition with slot) in Alt.1/2/3 are also included.
	+ Note2: For PUSCH repetition type A and B with frequency hopping, the variants considering frequency hop level beam mapping with the same mapping principals (replacing repetition with frequency hop) in Alt.1/2/3 can also be studied further. Final selection of such schemes also depends on the number of beams allowed per PUSCH repetition.
* For PUSCH repetition Type B, which repetition type that the beams shall consider for the mapping,
	+ Alt.1: beams are mapped to the nominal repetitions
	+ Alt.2: beams are mapped to the actual repetitions
	+ Alt.3: beams are mapped to different slots (not in the granularity of actual/nominal repetition)
	+ Alt.4: Other variants
* Consider additional requirements on switching gap(s) between two PUSCH repetitions towards different TRPs considering beam switching latency aspects.
* Note: use of the above solutions to multi-DCI based PUSCH repetition and TDMed PUSCH transmission without repetition (when there are agreed to support) is not precluded.

Multi-TRP enhancements for multi-cell mTRP:

**Agreement**

Study the following aspects of QCL /TCI-related enhancement to enable inter-cell multi-DCI based multi-TRP operation.

* Details on configuration of non-serving cell RS;
* Allowed source and target RS types for RS transmitted from the non-serving cell TRP ;
* Allowed QCL types for RS transmitted from the non-serving cell TRP ;
* Measurement and reporting related to QCL /TCI enhancement except for that in 8.1.1, if any;
* Clarification on potential UE behavior for associating/multiplexing non-serving cell RS with other RS/channels;
* Other details not precluded.

Multi-TRP enhancements for beam management:

**Agreement**

For L1-RSRP, consider measurement / reporting enhancement to facilitate inter-TRP beam pairing

* Option-1: Group-based reporting,
	+ e.g., beam restriction to facilitate inter-TRP pairing.
* Option-2: Non-group-based reporting

**Agreement**

Evaluate and study at least but not limited to the following issues for multi-beam enhancement

* Issue 1: Consideration of inter-beam interference
* Issue 2: For group-based reporting, increased number of groups and/or beams per group
* Issue 3: UE Rx panel related beam measurement/report
	+ NOTE: “UE panel” is used for discussion purpose only

**Agreement**

* Evaluate enhancement to enable per-TRP based beam failure recovery starting with Rel-15/16 BFR as the baseline.
* Consider following potential enhancement aspects to enable per-TRP based beam failure recovery
	+ Issue 1: TRP-specific BFD
	+ Issue 2: TRP-specific new candidate beam identification
	+ Issue 3: TRP-specific BFRQ
	+ Issue 4: gNB response enhancement
	+ Issue 5: UE behavior on QCL/spatial relation assumption/UL power control for DL and UL channels/RSs after receiving gNB response

**Agreement**

Study Rel.17 enhancements on beam management for multi-TRPs with following priority

* High priority:
	+ Beam measurement/reporting enhancement
	+ Beam failure recovery for multi-TRP
* Low priority
	+ Simultaneous reception of same type of channel/RS with different QCL-TypeD
	+ Simultaneous reception of different type of channel/RS with different QCL-TypeD

**Agreement**

For L1-RSRP, consider measurement / reporting enhancement to facilitate inter-TRP beam pairing

* Option-1: Group-based reporting,
	+ e.g., beam restriction to facilitate inter-TRP pairing.
* Option-2: Non-group-based reporting

**Agreement**

Evaluate and study at least but not limited to the following issues for multi-beam enhancement

* Issue 1: Consideration of inter-beam interference
* Issue 2: For group-based reporting, increased number of groups and/or beams per group
* Issue 3: UE Rx panel related beam measurement/report
	+ NOTE: “UE panel” is used for discussion purpose only

**Agreement**

* Evaluate enhancement to enable per-TRP based beam failure recovery starting with Rel-15/16 BFR as the baseline.
* Consider following potential enhancement aspects to enable per-TRP based beam failure recovery
	+ Issue 1: TRP-specific BFD
	+ Issue 2: TRP-specific new candidate beam identification
	+ Issue 3: TRP-specific BFRQ
	+ Issue 4: gNB response enhancement
	+ Issue 5: UE behavior on QCL/spatial relation assumption/UL power control for DL and UL channels/RSs after receiving gNB response

Multi-TRP enhancements for HST-SFN:

**Agreement**

Proposal on evaluation methodology in section 2.1 of R1-2007244 with following modifications (yellow part of proposal is not agreed)

* FFS: Propagation condition for FR1, FR2 whether CDL extension is optional or baseline
* FFS: UE height for both FR1, FR2

**Agreement**

For HST evaluation in FR2, Alt 2-3 is mandatory, other alternatives, i.e. Alt 2-4 and Alt. 2-1, are optional.

* Alt 2-1: Ds=700m, Dmin=150m
* Alt 2-3: Ds=200-300m, Dmin=30-50m
* Alt 2-4: Ds=580m, Dmin=5m

**R1-2007244** Summary#2 of AI: 8.1.2.4 Enhancements on HST-SFN deployment Intel Corporation

**Agreement**

* For Alt 2-1 in Table 1 - TRP height is 35m
* For Alt 2-3 in Table 1 - TRP height is 20m
* For Alt 2-4 in Table 1 - TRP height is 5m

**Agreement**

Adopt directional antenna model in Table 6 based on TR 38.802

Table 6 Antenna radiation pattern for UE

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element radiation pattern in $θ''$ dim (dB) |  |
| Antenna element radiation pattern in $φ''$ dim (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 5dBi |

**Agreement**

Antenna downtilt and azimuth directions point to the midpoint between the two TRPs

**Agreement**

UE height of 1.5m is baseline. Results for other UE heights can be reported by each company.

**Agreement**

The results should be reported

* Per track location (at specific SNR) or
* Throughput vs SNR at specific location
	+ Ds/2 (mid track point)
	+ Results for other locations can be reported by each company.

**Agreement**

CDL extension is baseline channel model for HST-SFN evaluations in addition to 4-tap channel model

**Agreement**

Number of TRP antenna ports for FR1 evaluations

* Support 8 antenna ports as optional configuration

**Agreement**

* Perfect synchronization as baseline
* Non-perfect time and frequency synchronization between the TRPs and UE, i.e., modeling of TRP CFO error (where CFO have temporal variation), UE receiver CFO, TRP timing errors may be optionally considered
	+ Companies to provide details on how this was modelled in their evaluations
		- For example, uniform distribution between [-ppm ppm]\*fc (Hz) for each simulation point where fc is the carrier center frequency and the values of maximum frequency error in ppm are captured TR 38.101-1/2 and TR 38.104

**Agreement**

* It is recommended to provide results for SNR = 8, 12, 16, 20 dB
* Other SNR values are not precluded
* SNR defined relative ONLY to the reference point closest to TRP

**R1-2007315** Summary#3 of AI: 8.1.2.4 Enhancements on HST-SFN deployment Intel Corporation

**Agreement**

* Replace row “TRP antenna configuration including number of antennas, pattern, ports, orientation, etc” in Table 1 with following table

|  |  |  |
| --- | --- | --- |
| TRP antenna configuration including number of antennas, pattern, ports, orientation, etc | CDL based extension:**2 ports**: [Mg, Ng, M, N, P]=[1, 1, 8, 2, 2], antenna model in Table 5, 16-to-1 mapping is used to virtualize the 16 antenna elements in the adjacent columns with fixed weight to form an antenna**4 ports**: [Mg, Ng, M, N, P]=[1,1,8,4,2], antenna model in Table 5, virtualization, 16-to-1 mapping is used to virtualize the 16 antenna elements in the two adjacent columns with fixed weight to form an antenna**Optional 8 ports:** [Mg, Ng, M, N, P]=[1, 1, 8, 4, 2], antenna model in Table 5, 8-to-1 mapping is used to virtualize the 8 antenna elements in a column with fixed weight to form an antenna port4-tap channel model: **2 ports**: omni-directional, MIMO matrix according to TS 38.101-4 (Annex B.1)**4 ports and 8 ports**: antenna model and mapping are the same as for CDL based extensionNote: The results for other antenna configurations can be also provided | 2 ports: [Mg, Ng, M, N, P]=[1, 1, 4, 8, 2],Antenna model in Table 5Note: The results for other antenna configurations can be also provided |

Table 5 Antenna radiation pattern for TRP

|  |  |  |
| --- | --- | --- |
| **Radiation power pattern of a single antenna element for TRP** | Vertical cut of the radiation power pattern (dB) |  |
| Horizontal cut of the radiation power pattern (dB) |  |
| 3D radiation power pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 8 dBi |

**Agreement**

For the discussion purpose consider the following categorization of the enhanced DL transmission schemes

* **Scheme 1**:
	+ TRS is transmitted in TRP-specific / non-SFN manner
	+ DM-RS and PDCCH/PDSCH from TRPs are transmitted in SFN manner
* **Scheme 2**:
	+ TRS and DM-RS are transmitted in TRP-specific / non-SFN manner
	+ PDSCH from TRPs is transmitted in SFN manner

**Agreement**

Study the following aspects of the enhanced transmission schemes:

* **For scheme 1**:
	+ Target DL physical channels, i.e., PDSCH only or PDSCH + PDCCH
	+ Whether more than 2 QCL/TCI states are required and corresponding signaling details
	+ Whether and how to indicate scheme 1 for differentiation with Rel-16 non-SFNed transmission schemes with multiple QCL/TCI states
	+ QCL relationship between TRS and DMRS ports
	+ Note: Other schemes/aspects are not precluded
* **For scheme 2**:
	+ Association of each MIMO layer of PDSCH to DM-RS antenna ports
	+ Whether more than 2 QCL/TCI states are required and corresponding signaling details
	+ Whether and how to indicate scheme 2 for differentiation with Rel-16 non-SFNed transmission schemes with multiple QCL/TCI states
	+ Note: Other schemes/aspects are not precluded

**Agreement**

For discussion purpose consider the following three steps for TRP-based frequency offset pre-compensation scheme:

* **1st step**: Transmission of the TRS resource(s) from TRP(s) without pre-compensation
* **2nd step**: Transmission of the uplink signal(s)/channel(s) with carrier frequency determined based on the received TRS signals in the 1st step
* **3rd step**: Transmission of the PDCCH/PDSCH from TRP(s) with frequency offset pre-compensation determined based on the received signal/channel in the 2nd step
* Note: A second set of TRS resource(s) may be transmitted at 3rd step.

**Agreement**

Study TRP-based frequency offset pre-compensation including the following aspects:

* Aspects related to indication of the carrier frequency determined based on the received TRS resource(s) in the 1st step
	+ **Option 1**: Implicit indication of the Doppler shift(s) using uplink signal(s) transmitted on the carrier frequency acquired in the 1st step
		- Indication for QCL-like association of the resource(s) received in the 1st step with UL signal transmitted in the 2nd step
		- Type of the uplink reference signals / physical channel used in the 2nd step, necessity of new configuration and corresponding signaling details
	+ **Option 2**: Explicit reporting of the Doppler shift(s) acquired in the 1st step using CSI framework
		- FFS: Indication for QCL-like association of the resource(s) received in the 1st step with UL signal transmitted in the 2nd step
		- CSI reporting aspects, configuration, quantization, signalling details, etc.
* New QCL types/assumption for TRS with other RS (e.g., SS/PBCH), when TRS resource(s) is used as target RS in TCI state
* New QCL types/assumptions for TRS with other RS (e.g., DM-RS), when TRS resource(s) is used as source RS in the TCI state
* Target physical channels (e.g., PDSCH only or PDSCH/PDCCH) and reference signals that should be supported for pre-compensation
* Signaling/procedural details on whether/how the pre-compensation is applied to target channels
* Whether multiple sets of TRS and pre-compensation on TRS is needed in 3rd step.
* Note: Other aspects/schemes are not precluded

SRS enhancements:

**Agreement**

LLS is used to evaluate SRS enhancements in Rel-17 FeMIMO, while SLS can be used additionally for evaluating data throughput for a given SRS design.

**Agreement**

Adopt the following LLS assumptions at least for SRS enhancements on coverage/capacity in Rel-17.

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Metric | UL/DL BLER or throughputNote: Other metrics like MSE can be considered optionally.  |
| Baseline | Rel-15 SRS. Companies to state the detailed configuration used as baseline scheme.Note: It has been agreed that FG 10-11 can be applied on licensed band. If no further restriction on the usage of FG 10-11 is agreed in Rel-16, it can be included in baseline. |
| Carrier frequency, SCS, System BW | FR1: 3.5GHz, 30kHz, 20, 40 or 100 MHz as baseline, 4GHz can be optionally usedFR2: 30 GHz, 120kHz |
| Channel model | CDL-B or CDL-C in TR 38.901 with 30ns or 300ns delay spread as baseline for MU-MIMO and SU-MIMONote: Other delay spread is not precluded. Note: Simulation using TDL-A with 30ns or 300ns for MU-MIMO is not precluded. Companies to state whether angle scaling is performed, and if so, the desired angle spread and mean angle. |
| UE speed | 3km/h , 30km/h or 120km/h  |
| Number of UE antennas  | 1T4R, 2T4R or 4T4R |
| Number of gNB antennas | 32T32R or 64T64R |
| UE antenna configuration | FR1: omni as baseline* Companies are not precluded to simulate directional antennas for 4Tx

FR2: directional |
| Rank, precoder and MCS  | Precoder is adaptive. Rank/MCS can be adaptive or fixed. |
| Precoding granularity | Fixed: 2, 4 or wideband for DL, wideband for UL. |
| SRS periodicity  | Companies to state the used SRS periodicity. |
| SRS Comb | Comb 2 or 4 |
| SRS frequency hopping | Companies to state whether SRS frequency hopping is enabled and the hopping pattern if so. |
| DL SNR | Companies to state the used difference between DL SNR and UL SNR |
| Phase coherency | Companies to state whether the phase coherency in time domain is modelled and if so, use the following * + Random phase rotation of each SRS transmission is modeled as a uniform distribution between [-*φmax, φmax* within a time window of *Twindow*$T\_{window}$, where companies should state the value of *φmax* and *Twindow*.
	+ Companies can choose from the following two options for $ϕ\_{max}$*φmax*
		- Opt-1: 40 degrees
		- Opt-2: pi\*Δf\*x/Ts, where Δf denotes the gap between central frequency and UE's SRS frequency position and Ts for sampling frequency. x can be 0.1, 0.2, 0.4
	+ *Twindow* = 20ms
	+ Other values of *φmax* and *Twindow* are not precluded
 |

**Agreement**

Adopt the following SLS assumptions at least for SRS capacity enhancements in Rel-17.

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Metric | DL throughput |
| Baseline | Rel-15 SRS. Companies to state the detailed configuration used as baseline scheme. Note: It has been agreed that FG 10-11 can be applied on licensed band. If no further restriction on the usage of FG 10-11 is agreed in Rel-16, it can be included in baseline. |
| SRS error modelling | Table A.1-2 of TR 36.897Δ=9 dB is assumed for baseline. Companies to state the detailed SRS configuration if it is different from baseline.Note: The phase coherency model in LLS assumptions can be considered additionally.  |
| SRS periodicity | Companies to state the simulated SRS periodicity.Note: SRS triggering may be aperiodic |
| Carrier frequency,  SCS and system bandwidth | 3.5GHz, 30KHz and 20MHz/40MHz/100MHz as baseline |
| Number of gNB antennas | (*M*, *N*, *P*, *M*g,*N*g; *M*p, *N*p) = (8,8,2,1,1,4,8). (dH,dV) = (0.5, 0.8)λ |
| Number of UE antennas | 1T4R, 2T4R or 4T4ROmni antennas are used as baseline. Companies are not precluded to simulate directional antennas for 4Tx. |
| Traffic model | FTP 1 or FTP 3 with 20%, 50% or 70% traffic loadNote: Full buffer can also be considered optionally. |
| Handover margin | 3dB |
| Scenario | UMi/UMa with 200m ISD.Note: UMa with 500m ISD can also be considered.Note: Simulation of rural scenario with necessary adjustment of relevant parameters is not precluded. |
| Duplex, Waveform  | TDD, OFDM  |
| Multiple access  | OFDMA  |
| Channel model | According to the TR 38.901  |
| BS Tx power  | 44, 47, and 51 dBm for 20, 40, and 100 MHz, respectively |
| BS antenna height  | 25 m  |
| UE antenna height & gain | Follow TR 36.873  |
| UE receiver noise figure | 9 dB |
| Modulation  | Up to 256QAM  |
| Coding on PDSCH  | LDPCMax code-block size=8448bit  |
| Slot | 14 OFDM symbols |
| Frame structure  | Companies to state the used frame structure |
| MIMO scheme | SU/MU-MIMO |
| Overhead  | Companies to state the downlink overhead assumption |
| UE distribution | 80% indoor (3km/h), 20% outdoor (30km/h)  |
| UE receiver | MMSE-IRC as the baseline receiver |

**Agreement**

Enhance the determination of aperiodic SRS triggering offset, with at least one of the following alternatives

* + Alt 1: Delay the SRS transmission to an available slot later than the triggering offset defined in current specification, including possible re-definition of the triggering offset
	+ Alt 2: Indicate triggering offset in DCI explicitly or implicitly
	+ Alt 3: Update triggering offset in MAC CE
	+ Further consideration aspects may include the cost v.s. the total combinations PDCCH and SRS locations for gNB to choose, DCI overhead, multi-UE SRS multiplexing, CA aspect, whether to have multiple opportunities to transmit SRS, etc.

R1-2007234 FL summary #3 on SRS enhancements Moderator (ZTE)

**Agreement**

For SRS coverage/capacity enhancements, evaluate and, if needed, specify one or more from three categories based on the following definition.

* + Class 1 (Time bundling): Utilize relationship among two or more occasions of one or more SRS resources in one or more slots to enable joint processing within time domain.
		- Study aspects include the issue of phase discontinuity, interruption of SRS transmission by other UL signals, etc..
	+ Class 2 (Increase repetition): Change the legacy SRS pattern in one resource and one occasion from time domain by increasing SRS symbols for repetition.
		- Study aspects include to use TD-OCC to compensate the negative impact on SRS capacity, inter-cell interference randomization, whether these SRS symbols are in one slot or consecutive slots, etc..
	+ Class 3 (Partial frequency sounding): Support more flexibility on SRS frequency resources to allow SRS transmission on partial frequency resources within the legacy SRS frequency resources.
		- Study aspects include the partial frequency resources are with RB level or subcarrier level (e.g., larger comb, partial bandwidth), PAPR issue, etc..

**Agreement**

Study the following two alternatives in the scope to enhance at least one DCI format for aperiodic SRS triggering

* + Alt 1: Use UE-specific DCI, e.g., extending DCI 0\_1 without uplink data and without CSI
	+ Alt 2: Use group-common DCI, e.g., extending DCI 2\_3 for cases other than carrier switching
	+ Further consideration aspects may include simultaneous or CC-specific SRS triggering for multiple CCs, dynamic indication of SRS frequency resources, etc..

**Agreement**

For SRS overhead reduction, study reusing same resources among multiple usages, at least for “codebook” and “antenna switching”. Study aspects include

* + Whether implementation approach based on legacy SRS configuration is sufficient
		- If not, and if there are benefits other than RRC overhead reduction, study further on the case that antenna switching and PUSCH have different number of Tx antennas, whether UL BWP for different SRS usages is the same or different, whether and how to ensure UE to use same virtualization, the set of applicable usages, UE implementation complexity and overhead, etc..

**Agreement**

For SRS antenna switching up to 8Rx, study the configuration of {1T6R, 1T8R, 2T6R, 2T8R, 4T6R, 4T8R}.

* + Study points may include CSI latency, performance considering aspects like insertion loss, use cases, antenna structure, UE power saving, SRS resource configuration, etc..

CSI enhancements:

**Agreement**

The EVM assumptions in Section 4 (except for Proposal 2 and 4) of R1-2006973 for Rel-17 CSI enhancements are agreed.

**Agreement**

For EVM for FDD CSI enhancement in Rel-17, use following Alt 1 as the baseline and Alt 2 as the optional

* Alt 1: Based on Section 5.3 of TR 36.897, to generate FDD DL and UL channels.
* Alt 2: Based on Section 7.6.5 of TR 38.901, to generate FDD DL and UL channels with following modifications:
	+ Different per-cluster shadowing is generated for DL and UL, and DL (or UL) angles are generated based on DL (or UL) cluster powers. Then UL (or DL) uses the same angles and its own cluster powers to generate the channel matrix.
	+ XPR is generated independently for DL and UL.

**Agreement**

For EVM for FDD CSI enhancement in Rel-17, using the following calibration error model



*  is the spatial UL channel at gNB side with calibration error
* $H\_{UL}$ is the ideal spatial UL channel without calibration error
* E represents the mismatch of transmission and reception circuits of gNB
* ai is the amplitude error
* θi is the phase error
* N is the number of antennas at gNB side

With amplitude error (expressed in decibel of $x=20log\_{10}a$) and phase error are normal distribution with 0.7dB and 5 degrees standard deviation, respectively. Both amplitude/phase errors are assumed to be constant during a simulation drop at time, and constant either across whole simulation bandwidth or per 4 PRB at frequency. Companies shall report the assumption of error modelling at frequency.

R1-2007268 Technical Categorization for CSI enhancements MTRP and FR1 FDD reciprocity Huawei, HiSilicon

**Agreement**

The EVM assumptions in Section 4 (except for Proposal 2 and 4) in R1-2006973 for Rel-17 CSI enhancements are agreed.

**Agreement**

Taking Type II port selection codebook enhancement (based on Rel.15/16 Type II port selection) as a starting point, study following aspects, taking into account trade-off among UE complexity, performance and reporting/RS overhead:

* Enhancement on codebook structure, e.g.,:
	+ (Alt 1)Enhancement based on R16 Type II PS CB type structure
		- Enhancements on *W1* quantization, e.g.,
			* With enhanced port selection in *W1*
			* With modified value range of *L* taking into account beamforming mechanism for CSI-RS;
			* With layer-specific port selection
		- Enhancements on *Wf* quantization, e.g.,
			* With a smaller value of *Mv*
			* With a modified value range of R
			* With multiple values of *Mv* for different SD basis
			* With enhanced FD basis selection in  *Wf*
		- Restrictions/Relaxation, e.g.
			* for the size of the PMI indicators for SD basis, FD basis and bitmap.
			* How UE distinguishes SD basis and FD basis or in a pre-defined set
		- Enhancement on *W2*quantization: coefficients for selected ports
	+ (Alt 2)Enhancement based on R15 Type II PS CB type structure
		- Enhancement on *W1* quantization, e.g.,: enhanced port selection, *X*$X$ out of *P* SD-FD pairs are selected
			* *X≤P* (if polarization independent) or *P*/2 (if polarization common) whereas *P ≤ PCSI-RS* only or *P* can be larger than *PCSI-RS*
			* How to map P SD-FD pairs into *PCSI-RS* CSI-RS ports and inform to UE
		- Enhancement on *W2* quantization: coefficients for the selected *X* pairs
	+ etc.
* Enhancements on indication/reporting mechanism, e.g.:
	+ Separate triggering for reporting of  *W1* and *Wf* $W\_{f}$ (for Alt 1) or reporting of *W1* and the rest of the PMI components (for Alt 2)
	+ Report only a subset of PMI components
	+ Enhancement on SD/FD basis indication, selection and reporting mechanism
	+ UE reporting to support gNB calibration including UL/DL time difference;
	+ CQI enhancements, e.g., CQI reporting mechanism considering FDD reciprocity
	+ etc.
* Enhancements on RS triggering/signaling/transmission mechanism, e.g. for SRS and/or CSI-RS, CSI-RS utilization conveying one or more SD-FD pairs per port, timing restrictions between SRS and CSI-RS transmission, etc
* Other enhancement are not excluded

**Agreement**

For CSI enhancement for multi-TRP, study following aspects taking into account trade-off among UE complexity, performance and reporting/RS overhead

* Category 1 - For a reporting setting CSI-ReportConfig, more than one CSI-RS port groups in a resource or resources or resource sets are associated to different TRPs/TCI states,
	+ the UE will determine CSI reporting quantities based on pre-defined/indicated/configured/UE-selected channel and interference hypotheses across TRPs /TCI states
	+ and then report one or more CSIs within a single CSI report.
* Category 2 – Within an implicit/explicit set of reporting settings CSI-ReportConfigs, which are associated to different TRPs/TCI states,
	+ the UE will determine CSI reporting quantities based on pre-defined/indicated/configured/ UE-selected channel and interference hypotheses
	+ and then report multiple CSIs with multiple CSI reports (including one or more CSIs per report or selected CSI with single CSI report)
* Other enhancement are not excluded, e.g. CQI enhancements for multi-TRP transmission including CQI format, CQI reporting mechanism

Note that companies are encouraged to clarify applicable transmission schemes/scenarios and strive to unify Rel-17 MTRP CSI framework enhancements

#### 2.1.2 Remaining Open issues

Multi-beam enhancements:

* Detailed design of unified TCI framework for common beam operation along with the associated dynamic signaling
* Detailed design of the spec support of fast panel selection for UL multi-panel UEs, along with MPE mitigation

Multi-TRP enhancements for PDCCH, PUSCH, and PUCCH:

* Detailed design for PDCCH reliability and robustness enhancements for multi-TRP
* Detailed design for PUCCH reliability enhancements, including decisions on supported schemes, beam configuration/mapping, power control aspects, and other.
* Detailed design for PUSCH reliability enhancements, including decisions on supported schemes and discuss the next level of details considering CB and non-CB based PUSCH, beam configurations/mapping, power control, and other

Multi-TRP enhancements for multi-cell mTRP:

* Detailed design on QCL /TCI-related enhancement to enable inter-cell multi-DCI based multi-TRP operation

Multi-TRP enhancements for beam management:

* Detailed design of beam measurement/reporting enhancement, beam failure recovery (including partial BFR) for mTRP and simultaneous reception of same/different channels/RS with different QCL-typeD

Multi-TRP enhancements for HST-SFN:

* Detailed solution on QCL assumption for DMRS antenna port(s) for HST-SFN deployment
* If the benefits are shown, detailed design of QCL/QCL-like relation between DL and UL signal for HST-SFN deployment

SRS enhancements:

* Detailed design of aperiodic SRS triggering enhancement considering flexibility and overhead
* Supported configurations of SRS antenna switching for up to 8Rx
* Detailed scheme for SRS coverage/capacity enhancement within the three Classes

CSI enhancements:

* Evaluate and, if needed, detailed design of CSI reporting for M-TRP/panel for more dynamic hypothesis, including related configuration, measurement behavior, reporting mechanism, UE capability design at least.
* Evaluate and, if needed, detailed design of PS codebook enhancement by utilizing FDD reciprocity, including related codebook structure, quantization, reporting mechanism, UE capability design at least.

## 2.2 RAN2

#### 2.2.1 Agreements

not yet started yet

#### 2.2.2 Remaining Open issues

not yet started yet

## 2.3 RAN3

n/a

#### 2.3.1 Agreements

#### 2.3.2 Remaining Open issues

## 2.4 RAN4

#### 2.4.1 Agreements

not yet started

#### 2.4.2 Remaining Open issues

not yet started yet

## 2.5 RAN5

n/a

#### 2.5.1 Agreements

#### 2.5.2 Remaining Open issues

#### 2.5.3 Remaining Open issues with cross-WG dependencies

## 2.6 RAN6

n/a

#### 2.6.1 Agreements

#### 2.6.2 Remaining Open issues

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

n/a

## 3.1 SAx/CTs

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

v04.81 31.07.2018 simplification of template and addition of cross-TSG aspects

v04.80 21.05.2018 minor adaptations for RAN #80

v04.79 26.02.2018 minor adaptations for RAN #79

v04.78 18.11.2017 minor adaptations for RAN #78

v04.77 06.08.2017 minor adaptations for RAN #77

v04.76 15.05.2017 minor adaptations for RAN #76

v04.75 31.01.2017 minor adaptations for RAN #75

v04.74 28.10.2016 minor adaptations for RAN #74

v04.73 01.09.2016 adaptations for RAN #73 (time units in extra Excel table, RAN6 reporting included)

v04.72 26.05.2016 adaptations for RAN #72 (introduction of NR & GERAN TUs)

v04.71 10.02.2016 minor adaptations for RAN #71

v04.70 30.10.2015 minor adaptations for RAN #70

v04.69 12.08.2015 minor adaptations for RAN #69

v04.68 21.05.2015 minor adaptations for RAN #68

v04.67 01.02.2015 minor adaptations for RAN #67

v04.66 16.11.2014 minor adaptations for RAN #66

v04.65 16.08.2014 minor adaptations for RAN #65

v04.64 22.05.2014 minor adaptations for RAN #64

v04.63 24.01.2014 restructuring for RAN #63 to cover Core & Perf. in one doc file

v03.62 11.11.2013 section 1.2.3 adapted for RAN #62

v03 11.08.2013 section 1.2.3 added on time budget

v02 07.05.2010 history added, some spelling corrections

v01 13.11.2009 First version of the template