**3GPP TSG RAN WG1 #101 R1-200xxxx**

**e-Meeting, May 25th – June 5th, 2020**

**Agenda item:** 7.2.6.3.

**Source:** Moderator (LG Electronics)

**Title:** Summary of email thread [101-e-NR-eMIMO-MB1-03]

**Document for:** Discussion and Decision

# Introduction

This contribution summaries discussion in email thread [101-e-NR-eMIMO-MB1-03]

# Proposals and Discussion

# Support the feature of default PL RS for PUSCH scheduled by DCI format 0\_1

Motivation: The feature of default PL RS is not applicable to PUSCH scheduled by DCI format 0\_1.

***Proposal from ZTE:***  *If the UE is provided enableDefaultBeamPlForSRS and is not provided path-loss RS for PUSCH, the path-loss RS for PUSCH scheduled by DCI format 0\_1 is determined according to the path-loss RS for its associated SRS resource set, i.e., for codebook or non-codebook transmission.*

***TP: {****38.213: 7.1.1 UE behaviour}*

|  |
| --- |
| - If the UE is provided *SRI-PUSCH-PowerControl* and more than one values of *PUSCH-PathlossReferenceRS-Id*, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in a DCI format scheduling the PUSCH transmission and a set of *PUSCH-PathlossReferenceRS-Id* values and determines the RS resource index  from the value of *PUSCH-PathlossReferenceRS-Id* that is mapped to the SRI field value where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*- If the PUSCH transmission is scheduled by a DCI format 0\_1, and if the UE is provided *enableDefaultBeamPlForSRS* and is not provided *PUSCH-PathlossReferenceRS-Id*, the UE uses the same RS resource index  as for the SRS resource set corresponding to the PUSCH transmission. |

**Proposal from DOCOMO:**

* **If the UE is provided *enableDefaultBeamPlForSRS* and is provided neither *PUSCH-PathlossReferenceRS* nor *PUSCH-PathlossReferenceRS-r16*, the PL-RS for PUSCH scheduled by DCI format 0\_1 is determined by the PL-RS of SRS resource with usage CB/NCB associated with SRI.**
	+ **Adopt the following TP in TS38.213 section 7.3.1:**

|  |
| --- |
| 7.3.1 UE behaviour[…]- If the UE is provided *SRI-PUSCH-PowerControl* and more than one values of *PUSCH-PathlossReferenceRS-Id*, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in a DCI format scheduling the PUSCH transmission and a set of *PUSCH-PathlossReferenceRS-Id* values and determines the RS resource index  from the value of *PUSCH-PathlossReferenceRS-Id* that is mapped to the SRI field value where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*- If the PUSCH transmission is scheduled by a DCI format 0\_1, and if the UE is provided *enableDefaultBeamPlForSRS* and is provided neither *PUSCH-PathlossReferenceRS* nor *PUSCH-PathlossReferenceRS-r16*, the UE uses the same RS resource index  as for the SRS resource set corresponding to the PUSCH transmission. |

For this issue, the proposed two TPs are quite similar and DOCOMO’s TP looks more updated with the Rel-16 RRC parameter. Companies please provide your views on the proposal below:

**Companies’ view (to be updated)**

|  |  |
| --- | --- |
| Company name | View |
| Apple | It seems Docomo’s TP is slightly better. But with the TP and the paragraph below, it looks both conditions would be true simultaneously.“- If the UE is not provided *PUSCH-PathlossReferenceRS* or before the UE is provided dedicated higher layer parameters, the UE calculates  using a RS resource from the SS/PBCH block that the UE uses to obtain *MIB”* |
| Ericsson | Not supportive of coupling SRS and PUSCH any further. Leave to R17. |
| ZTE | Support DOCOMO’s TP, which further considers Rel-16 RRC parameter for PUSCH path-loss RS compared with our TP. * + This is an essential feature that should be completed in Rel-16. Also, we wonder whether default beam approach is within Rel-17 FeMIMO scope or not.
	+ Regarding Apple’s comments, we can consider add one more condition of “the UE is NOT provided enableDefaultBeamPlForSRS” for the paragraph raised by Apple.
 |
| CATT | Slightly prefer the DOCOMO version. |
| Intel | OK with TP, but looks not essential correction due to lack of the agreement in Rel-16.  |
| Nokia/NSB | Looks good technical proposal and we are O.K. with Docomo’s TP. But this is not for error correction, but for further improvement. For the clarification. |
| MediaTek | Don’t support. This TP is the extended feature of the existing agreements. More assessment is required. |
| Qualcomm | We are fine with the concept, and slightly prefer DCM’s version |
| Samsung | Agree with Intel. |
| OPPO | It needs new agreement. Prefer not to do it. |
| CMCC | Support DOCOMO’s TP. |

# Default PL RS/spatial relation for multi-slot PUCCH

Motivation: When the default spatial relation/PL RS is enabled, it is unclear on which TCI state is used for determining spatial relation of PUCCH for each slot, especially when the repeated PUCCH slots cross the application timing of MAC-CE.

***Proposal from ZTE:*** *For multi-slot PUCCH, the default spatial relation and default path-loss RS of PUCCH in each slot is determining according to the recently active TCI state or QCL assumption of the CORESET with the lowest ID in the respective slot.*

***TP: {****38.213: 7.2.1 UE behaviour}*

|  |
| --- |
| If the UE- is not provided *pathlossReferenceRSs*, and- is not provided *PUCCH-SpatialRelationInfo,* and- is provided *enableDefaultBeamPlForPUCCH* - is not provided *CORESETPoolIndex* value of 1 for any CORESET, or is provided *CORESETPoolIndex* value of 1 for all CORESETs, in ControlResourceSetand no codepoint of a TCI field, if any, in a DCI format of any search space set maps to two TCI states [5, TS 38.212]  the UE determines a RS resource index  for each slot of the PUCCH transmission providing a RS resource with ‘QCL-TypeD’ in the active TCI state or the QCL assumption of a CORESET with the lowest index in the respective slot in the active DL BWP of the primary cell. <Unchanged parts are omitted> |

***TP: {****38.213: 9.2.2 PUCCH Formats for UCI transmission}*

|  |
| --- |
| If a UE- reports *beamCorrespondenceWithoutUL-BeamSweeping*, - is not provided *pathlossReferenceRSs* in *PUCCH-PowerControl*, - is provided *enableDefaultBeamPlForPUCCH*, and - is not provided *PUCCH-SpatialRelationInfo*, and- is not provided *CORESETPoolIndex* value of 1 for any CORESET, or is provided *CORESETPoolIndex* value of 1 for all CORESETs, in *ControlResourceSet*and no codepoint of a TCI field, if any, in a DCI format of any search space set maps to two TCI states [5, TS 38.212]  spatial domain filter for a PUCCH transmission from the UE in each slot of the PUCCH transmission is same as a spatial domain filter used for the reception of a RS resource with ‘QCL-TypeD’ in the active TCI state or the QCL assumption of the CORESET with the lowest ID in the respective slot on the active DL BWP of the PCell. |

**Proposal from Spreadtrum: Adopt text proposals (TP1/TP2) in 38.213.**

**Text Proposal-1(TP1): for Section 7.2.1 of 38.213:**

|  |
| --- |
| --------------------------------------------------------------------------------------------------------------------------< Unchanged parts are omitted >- If the UE- is not provided *pathlossReferenceRSs*, and- is not provided *PUCCH-SpatialRelationInfo,* and- is provided *enableDefaultBeamPlForPUCCH* the UE determines a RS resource index  providing a periodic RS resource with 'QCL-TypeD' in the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP of the primary cell. For multi-slot PUCCH, the *qd* derived from 1st PUCCH applies to all PUCCHs.< Unchanged parts are omitted >----------------------------------------------------------------------------------------------------------------------------  |

**Text Proposal-2(TP2): for Section 9.2.2 of 38.213:**

|  |
| --- |
| --------------------------------------------------------------------------------------------------------------------------< Unchanged parts are omitted >If a UE- reports *beamCorrespondenceWithoutUL-BeamSweeping*, - is not provided *pathlossReferenceRSs* in *PUCCH-PowerControl*, - is provided *enableDefaultBeamPlForPUCCH*, and - is not provided *PUCCH-SpatialRelationInfo*, a spatial setting for a PUCCH transmission from the UE is same as a spatial setting for PDCCH receptions by the UE in the CORESET with the lowest ID on the active DL BWP of the PCell. For multi-slot PUCCH, the spatial setting for 1st PUCCH transmission also applies to all PUCCHs.< Unchanged parts are omitted >----------------------------------------------------------------------------------------------------------------------------  |

For this issue, two different alternatives are identified.

* Alt1. For multi-slot PUCCH, the spatial relation to be applied for each PUCCH slot is determined in a per-slot basis.
	+ For Alt1, the TPs from ZTE can be a starting point.
* Alt2. For multi-slot PUCCH, a spatial relation is commonly applied across the PUCCH slots, where the spatial relation is determined by the first PUCCH slot.
	+ For Alt2, the TPs from Spreadtrum can be a starting point.

**Companies’ view (to be updated)**

|  |  |
| --- | --- |
| Company name | View |
| Apple | Support Alt1, which can achieve better performance. It is good to apply the new beam as soon as possible. |
| Ericsson | Support Alt 1. A configuration that is applicable from a certain time should apply to all transmissions from that point in time. |
| ZTE | Support Alt-1, but we can also live with Alt-2. In our perspective, a clear UE behavior for multi-slot PUCCH is required and very essential for implementation. |
| CATT | Support Alt.2. Similar principle has been adopted for PDSCH where the same TCI state is assumed through all slots. A consistent behavior between DL/UL is preferred for implementation simplicity. Regarding alt1, the potential performance benefits have not been quantitatively demonstrated.  |
| Intel | Alt 2 |
| Sony | Support Alt.2. Agree with CATT that the DL (same TCI-state for multi-slot PDSCH) and UL (spatial relation for multi-slot PUCCH) consistency matters. |
| Nokia/NSB | Support Alt. 1 |
| MediaTek | Support Alt. 2. Agree with CATT.  |
| Qualcomm | Support Alt.2. In R16, the spatial relation cannot change across slots for multi-slot PUCCH/PUSCH. We prefer not to introduce new rule to complicate implementation. Similar rule has been clarified for multi-slot PDSCH, i.e. TCI state of 1st slot will be used for the remaining slots. It is clarified in 28.214->5.1.5. We prefer no different rule introduced in late stage. |
| Samsung | Support Alt 2 for simple implementation. The potential performance gain from UL spatial diversity such as Alt 1 has not been studied yet and should be handled in Rel-17. |
| OPPO | Support Alt2 for simpler UE implementation. |
| vivo | Support Alt2 since the timing for applying spatial info is not deterministic. UE behavior would be complicated regarding different conditions, whether the TCI state is known, where SSB is measured etc. |
| CMCC | Support Alt 2.Agree with CATT that the TCI state for the 1st PUSCH transmission is applied to all PUSCH repetitions. |

# Support the feature of simultaneous spatial relation update across multiple BWPs/CCs when default spatial relation for SRS is enabled

Motivation: Current description in TS38.214 does not support enabling both features of the default spatial relation and the simultaneous update of spatial relation across multiple CCs simultaneously.

***Proposal from Vivo:***

* *Clarify UE behavior as in the following TP when the higher layer parameter enableDefaultBeamPlForSRS is set ‘enabled’ and the higher payer parameter simultaneousSpatial-UpdatedList-r16* or *simultaneousSpatial-UpdatedListSecond-r16 is configured.*

|  |
| --- |
| **TS 38.214****6.2.1 UE sounding procedure**< Unchanged parts are omitted >When a *~~spatialRelationInfo~~*spatial domain transmission filteris activated/updated for a semi-persistent or aperiodic SRS resource configured by the higher layer parameter *SRS-Resource* by a MAC CE for a set of CCs/BWPs, where the applicable list of CCs is indicated by higher layer parameter *simultaneousSpatial-UpdatedList-r16* or *simultaneousSpatial-UpdatedListSecond-r16*, the *~~spatialRelationInfo~~*spatial domain transmission filteris applied for the semi-persistent or aperiodic SRS resource(s) with the same SRS resource ID for all the BWPs in the indicated CCs.< Unchanged parts are omitted > |

**Proposal from Sony: If a UE is configured with higher layer parameter *enableDefaultBeamPlForSRS* on a CC, it shall not expect the CC to be included in either simultaneous spatial relation updating list, i.e. *simultaneousSpatial-UpdatedList-r16* and *simultaneousSpatial-UpdatedListSecond-r16*.**

|  |
| --- |
| < Start of the text proposal on TS 38.214 section 6.2.1 updated in R1-2003146>< Unchanged parts are omitted >When a *spatialRelationInfo* is activated/updated for a semi-persistent or aperiodic SRS resource configured by the higher layer parameter *SRS-Resource* by a MAC CE for a set of CCs/BWPs, where the applicable list of CCs is indicated by higher layer parameter *simultaneousSpatial-UpdatedList-r16* or *simultaneousSpatial-UpdatedListSecond-r16*, the *spatialRelationInfo* is applied for the semi-persistent or aperiodic SRS resource(s) with the same SRS resource ID for all the BWPs in the indicated CCs.When the higher layer parameter *enableDefaultBeamPlForSRS* is set ‘enabled’, and if the higher layer parameter *spatialRelationInfo* for the SRS resource, except for the SRS resource with the higher layer parameter *usage* in SRS-ResourceSet set to 'beamManagement' or for the SRS resource with the higher layer parameter *usage* in SRS-ResourceSet set to ‘nonCodebook’ with configuration of *associatedCSI-RS* or for the SRS resource configured by the higher layer parameter [SRS-for-positioning], is not configured in FR2 and if the UE is not configured with higher layer parameter(s) *pathlossReferenceRS*, and if the UE is not configured with different values of *CORESETPoolIndex* in *ControlResourceSets*, and is not provided at least one TCI codepoint mapped with two TCI states, the UE shall transmit the target SRS resource - with the same spatial domain transmission filter used for the reception of the CORESET with the lowest *controlResourceSetId* in the active DL BWP in the CC.- with the same spatial domain transmission filter used for the reception of the activated TCI state with the lowest ID applicable to PDSCH in the active DL BWP of the CC if the UE is not configured with any CORESET in the active DL BWP of the CCnd the UE shall not expect the CC to be included in the applicable list of CCs indicated by higher layer parameter *simultaneousSpatial-UpdatedList-r16* or *simultaneousSpatial-UpdatedListSecond-r16*.< Unchanged parts are omitted >< End of the text proposal on TS 38.214 section 6.2.1 updated in R1-2003146> |

For this issue, two different alternatives are identified. For Alt1, in addition to the TP from Vivo, further description in specification may be required for clarifying this operation.

* Alt1. For a same CC, the feature of the simultaneous multi-CC spatial relation update for SP/AP SRS and the feature of the default spatial relation for SRS can be enabled simultaneously.
	+ When both are enabled for a same CC by relevant RRC parameters, the *spatialRelationInfo* of the SRS resources with same ID in the *simultaneousSpatial-UpdatedList-r16* or *simultaneousSpatial-UpdatedListSecond-r16* cannot be configured, and the update of spatial domain transmission filter of the SRS resources with same ID in the *simultaneousSpatial-UpdatedList-r16* or *simultaneousSpatial-UpdatedListSecond-r16* follows the default beam.
	+ For Alt1, the TP from Vivo can be a starting point.
* Alt2. For a same CC, the feature of the simultaneous multi-CC spatial relation update for SP/AP SRS and the feature of the default spatial relation for SRS cannot be enabled simultaneously.
	+ For Alt2, the TP from Sony can be a starting point.

**Companies’ view (to be updated)**

|  |  |
| --- | --- |
| Company name | View |
| Apple | It looks the two features can be enabled simultaneously from RRC signaling perspective. We failed to see problems for this. If spatial relation is provided by MAC CE, no matter whether it is MAC CE to update beam for a single CC or multiple CCs, the default beam would not be applied.  |
| Ericsson | Agree with Apple. Default beams only apply if no signaling is provided, and there is no additional impact of the cross-CC updates. We do not support the TP from vivo, it is the spatial relation info that is activated/updated. |
| ZTE | We share the same views with Apple and Ericsson. Besides, it seems that the current spec is sufficient, considering that condition, e.g., of “the higher layer parameter spatialRelationInfo for the SRS resource is not configured in FR2”, which means that, once the multi-CC function is enabled, the default beam approach is disabled accordingly. |
| CATT | Agree with Apple/Ericsson. These two features can be enabled simultaneously. The proposed CR related to Alt.1 doesn’t seem necessary.  |
| Intel | Not clear what problem TP is trying to solve. Need more details from the proponents.  |
| Sony | Thank you all for the discussion. We respect the configuration flexibility that RRC signaling can enable the two features mentioned above simultaneously. When both configured, we hope the UE behavior is or to be clear in Spec. More specifically, it seems that many companies believe that UE applies the default beam for SRS resource until the MAC CE simultaneously updates spatial relation of SRS resources across BWPs/CCs. But we just fail to find the corresponding text or any hint in Spec. |
| Nokia/NSB | Agree with Apple/Ericsson/CATT. No further TP looks needed. |
| MediaTek | Don’t support both TPs. Agree with Apple/Ericsson/CATT/Nokia. |
| Qualcomm | Our understanding is that both features can coexist. NW can update the beam of CORESET with lowest ID across CCs, then the default beam follows that CORESET beam per CC, which can be identical across CCs. So the issue may not exist.  |
| Samsung | Do not support the TPs. Share the same view with Apple/Ericsson/CATT/Nokia. |
| OPPO | Agree with Apple/Ericsson/CATT/Nokia/Samsung, these TPs are not needed. |
| vivo | It seems that ZTE thinks the two features cannot be enabled simultaneously, but others think they can.Re Apple/Ericsson/CATT/Nokia/Samsung/OPPO/Qualcomm, there is the following restriction that *spatialRelationInfo,* thus current description is restrictive to enable the simultaneous operation of the two features.“When the higher layer parameter enableDefaultBeamPlForSRS is set 'enabled', and if the higher layer parameter spatialRelationInfo for the SRS resource, except for the SRS resource with the higher layer parameter usage in SRSResourceSet set to 'beamManagement' or for the SRS resource with the higher layer parameter usage in SRSResourceSet set to 'nonCodebook' with configuration of associatedCSI-RS or for the SRS resource configured by the higher layer parameter [SRS-for-positioning], is not configured in FR2 and if the UE is not configured with higher layer parameter(s) pathlossReferenceRS, the UE shall transmit the target SRS resource - with the same spatial domain transmission filter used for the reception of the CORESET with the lowest controlResourceSetId in the active DL BWP in the CC. - with the same spatial domain transmission filter used for the reception of the activated TCI state with the lowest ID applicable to PDSCH in the active DL BWP of the CC if the UE is not configured with any CORESET in the CC” |
| CMCC | Support vivo’s TP.We understand the intention of vivo’s TP is to clarify the following case:* The *spatialRelationInfo* for SRS is not configured and *enableDefaultBeamPlForSRS* is set 'enabled', the default spatial relation of SRS is applied, such as the QCL-Type D of the CORESET with the lowest ID.
* Then, the QCL-Type D of the CORESET is updated by the feature of simultaneous update of TCI state across multiple CCs.

Whether the default spatial of SRS is updated or not?Our understanding is the default SRS is updated. So, in the vivo’s TP, the *spatialRelationInfo* is revised by spatial domain transmission filter to including this case. |

# Action time for PDSCH/PUSCH beam indication

Motivation: In Rel-16, MAC-CE based DL/UL beam update across multiple CCs is supported so more frequent beam updates by MAC-CE is expected. If PDSCH/PUSCH beam is updated by MAC-CE for the cases of no TCI present in DCI for PDSCH or for PUSCH scheduled by DCI 0\_0, the beam to be applied by the UE is ambiguous when the scheduling PDCCH is transmitted before the activation time of the MAC-CE as illustrated below.



In this case, there can be two different implementation options:

* Option 1: UE follows the TCI state for the CORESET in PDCCH slot
* Option 2: UE follows the TCI state for the CORESET in PDSCH slot

Proposal from Apple:

***Proposal: If TCI is not present in DCI and scheduling offset is larger than the threshold, The PDSCH beam should be based on the QCL/TCI applied for the CORESET with scheduling PDCCH in the first PDSCH slot.***

* ***Adopt the following TP for 38.214***

|  |
| --- |
| **5.1.5 Antenna ports quasi co-location**< Unchanged parts are omitted >If a UE is configured with the higher layer parameter *tci-PresentInDCI* that is set as 'enabled'for the CORESET scheduling the PDSCH, the UE assumes that the TCI field is present in the DCI format 1\_1 of the PDCCH transmitted on the CORESET. If a UE is configured with the higher layer parameter *tci-PresentInDCI-ForFormat1\_2* for the CORESET scheduling the PDSCH, the UE assumes that the TCI field with a DCI field size indicated by *tci-PresentInDCI-ForFormat1\_2* is present in the DCI format 1\_2 of the PDCCH transmitted on the CORESET. If the PDSCH is scheduled by a DCI format not having the TCI field present, and the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than a threshold *timeDurationForQCL* if applicable, where the threshold is based on reported UE capability [13, TS 38.306], for determining PDSCH antenna port quasi co-location, the UE assumes that the TCI state or the QCL assumption for the PDSCH is identical to the TCI state or QCL assumption whichever is applied for the CORESET used for the PDCCH transmission in the slot with the scheduled PDSCH.  |

***Proposal: When PUSCH is scheduled by DCI format 0\_0, its spatial relation should follow the that of PUCCH with lowest ID in PUSCH slot.***

* ***Adopt the following TP for 38.214***

|  |
| --- |
| 6.1 UE procedure for transmitting the physical uplink shared channel< Unchanged parts are omitted >For PUSCH scheduled by DCI format 0\_0 on a cell, the UE shall transmit PUSCH according to the spatial relation, if applicable, corresponding to the dedicated PUCCH resource with the lowest ID within the active UL BWP of the cell in the slot with scheduled PUSCH, as described in Subclause 9.2.1 of [6, TS 38.213]. < Unchanged parts are omitted > |

For this issue, Apple proposed two TPs for option 2. Companies please provide your views on your preferred option and TP below:

**Companies’ view (to be updated)**

|  |  |
| --- | --- |
| Company name | View |
| Apple | Support TPs |
| Ericsson | Do not support the TPs.A configuration for a transmission applies when the transmission occurs. This is a general principle, and there is no need to highlight it. This is not a discussion we should have for any configuration, since it would imply that it needs to be confirmed for every configuration. |
| ZTE | Support in principle. The wording may need to be polished.As a baseline, we believe that at least one clear conclusion for this issue is needed for the perspective of gNB and UE implementation. |
| CATT | Fine with the TP.  |
| Intel | TP may not be needed. Prefer to capture this as conclusion. |
| Sony | Support in principle. Similar as we handled spatial relation of Ap-SRS + MAC CE updating in 100b e-meeting, we may first try to draw conclusion and then adopt TP(s) correspondingly.  |
| Nokia/NSB | Support in Principle.  |
| MediaTek | Don’t support TPs. Agree with Ericsson and Intel. If this is a general principle, it can be captured by conclusion.  |
| Qualcomm | Similar issue is already clarified for AP SRS as a conclusion. We are fine to capture the TP in the same way.  |
| Samsung | Do not support the TP. Share the same view with Ericsson. |
| OPPO | Support the TP. They are good clarification.  |
| vivo | We are supportive of clarification on the corresponding behaviors.  |
| CMCC | Support the TP. If the TP is not agreed, at least a conclusion is needed. |

# Conclusion (to be updated)

From the email discussion [101-e-NR-eMIMO-MB1-03], xxx

# References

|  |  |  |
| --- | --- | --- |
| **TDoc** | **Title** | **Source** |
| [**R1-2003398**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2003398.zip) | On remaining issues on Multi Beam | vivo |
| [**R1-2003470**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2003470.zip) | Maintenance of multi-beam operation | ZTE |
| [**R1-2003985**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2003985.zip) | Discussion on remaining issues of multi-beam operation | Spreadtrum Communications |
| [**R1-2004186**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2004186.zip) | Remaining issues on multi-beam operation | Sony |
| [**R1-2004230**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2004230.zip) | Remaining issues on beam management enhancement | Apple |
| [**R1-2004396**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2004396.zip) | Remaining issues on multi-beam operation | NTT DOCOMO, INC |