**3GPP TSG-RAN WG4 Meeting #94-e R4-2002694**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.14.1.2

**Source:** Moderator (Apple)

**Title:** Email discussion summary for RAN4#94e\_#21\_NR\_RF\_FR2\_req\_enh\_Part\_2

**Document for:** Information

# Introduction

The beam correspondence topic area includes the following topics:

1. Topic 1: beam correspondence based on SSB
2. Topic 2: beam correspondence based on CSI-RS
3. Topic 3: initial access beam correspondence
4. Topic 4: additional beam correspondence enhancements
5. Topic 5: beam correspondence capability aspects

Each topic consists of sub-topics, as captured in the following sections.

During the first round of email discussions, it is recommended to converge on the following aspects of each topic:

1. Topic 1: side conditions and performance difference aspects (2.2.1, 2.2.2)
2. Topic 2: how to achieve ”CSI-RS only condition” and remaining aspects of side conditions (3.2.1, 3.2.2)
3. Topic 3: whether a feasible solution can be identified (4.2.1)
4. Topic 4: which, if any, beam correspondence enhancements are feasible within the Rel-16 timeframe (5.2.1, 5.2.2, 5.2.3)

During the second round of email discussion, it is recommended to converge further Topics 1 through 4 and to also address the beam correspondence capability aspects (Topic 5).

# Topic #1: Beam correspondence based on SSB

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2000012](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000012.zip) | Apple Inc. | Observation 1: If we consider a beam refinement procedure based on SSB from the perspective of UE functionality under a sub-optimal network configuration which does not include CSI-RS for the P3 procedure, then it may be helpful to consider a requirement on SSB based beam correspondence with the understanding that performance between SSB based and SSB+CSI-RS based beam correspondence are taken into account, as summarized in [10]. |
| [R4-2000077](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000077.zip) | Qualcomm Incorporated | Proposal 1: For SSB-based eBC, P3 CSI-RS is not configured.  Proposal 2: For SSB-based eBC, minimum TR SNR is equal to or greater than minimum SSB SNR.  Proposal 3: PSD of reference signal (RS) used by the UE to achieve beam correspondence shall be the same, regardless of RS type (SSB or CSI-RS) |
| [R4-2000271](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000271.zip) | Samsung | Observation 1: SNR side condition for SSB based BC is limited by testability SNR range, and BC performance is impacted due to less RS available.  Observation 2: From RF test point of view, SSB based BC is not suitable to specify with MOP metric.  Proposal 1: SSB based BC is not specified, or to be specified with other metric instead of MOP metric. |
| [R4-2000394](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000394.zip) | Intel Corporation | Observation 1: CSI-RS is a UE specific reference signal and can only be configured when UE is in RRC connected mode.  Observation 2: When UE is in RRC connected mode, side condition of SSB + tracking CSI-RS can be used for UE to fine tune “narrow beam” for beam correspondence.  Observation 3: A UE is able to finish initial access and establish RRC connection with network without sacrificing the cell coverage with â€˜fatâ€™ beams  Proposal 1: Updated parameter table for SSB based beam correspondence should be as table 1   |  |  | | --- | --- | | **Parameter** | **Value** | | SSB periodicity | 20 ms [1] | | Use P1 CSI-RS configuration? | No | | Use P3 CSI-RS configuration? | ~~Alt. 1: Yes~~  Alt. 2: No | | Use tracking CSI-RS? | Yes | | Tracking CSI-RS QCL info | qcl-TypeD=SSB | | Tracking CSI-RS min SNR | ~~TBD~~  6dB | | Tracking CSI-RS resource sets | 2 NZP CSI-RS resource sets, set0 and set1; each resource set has 4 periodic resources over two consecutive slots | | Tracking CSI-RS resource periodicity | 20 ms | | Tracking CSI-RS resource time domain location and slot offsets | Resource mapping: Set0: l{0,4}, set1: l{0,4};  Slot offset: set0 = 2µ10; set1 = 2µ10 +2; | | Tracking CSI-RS resource frequency domain configuration | = 3; 48RBs for BW=100/200/400MHz, 32RBs for BW=50MHz | | PDCCH/PDSCH DM-RS QCL info | qcl-TypeD=TRS | | SSB min SNR level | Alt. 1: 6 dB [1] [10]  ~~Alt. 2: 13 dB [14]~~ | | (note) | RAN4 didn’t assume more than [1] SSB indices should be transmitted  SSB use configuration for Rel-15 which is specified in 38.508 per agreed in RAN4 #92bis meeting |   Proposal 2: When SSB periodicity =20ms, a UE should meet Rel15 beam correspondence requirements without CSI-RS assistance under the condition 1) SNR = 6dB, 2) For each test grid point, at least 3 SSB bursts should be provided for beam refinements. |
| [R4-2000791](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000791.zip) | Apple Inc. | Observation 1: It is unrealistic to assume the codebook size of Rx beamforming for SSB measurement more than 8. Rx refinement for SSB based L1 and L3 measurement cannot be easily assumed too.  Observation 2: The effective codebook size of Rx beamforming for CSI-RS measurement can be much larger than SSB’s due to Rx refinement and potential relaxed measurement delay requirements.  Observation 3: To be consistant with SNR assumption of Rel-15 BC requirement, 6dB of SSB SNR should be considered.  Observation 4: Up to 4.7 dB EIRP performance degradation are observed for 2x2 array with different RSRP implementation margin.  Observation 5: Up to 5.0 dB EIRP performance degradation are observed for 4x1 array with different RSRP implementation margin.  Proposal: Considering a significant EIRP spherical performance degradation with SSB based BC, there can be two options  Option 1: Introduce a performance relaxation margin for SSB based BC. The exact margin is TBD  Option 2: No specify the requirements for SSB based BC. |
| [R4-2000858](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000858.zip) | NTT DOCOMO | Observation 1: According to Rel-15 test parameter for beam correspondence, both SSB and CSI-RS with repetition are transmitted by the same Tx beam from gNB and UE would assume the same spatial Rx parameters to receive both signals.  Proposal 1: Beam correspondence requirements based on only SSB should be specified in Rel-16.  Proposal 2: There are no technical issues on beam correspondence based on only SSB and the performance can be the same as that in Rel-15. |
| [R4-2001199](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001199.zip) | LG Electronics | Observation 1: The new EIRP requirements by SSB based enhanced BC could not guarantee the existing EIRP requirements for BC in rel-15.  Observation 2: It is quite burden to specify both SSB based eBC and CSI-RS based eBC in rel-16 since the expected OTA test time will be raised some high cost UE.  Proposal 1: RAN4 only specified CSI-RS resource based enhanced BC requirements to reduce OTA test time and keep the current EIRP (peak and spherical) in rel-15 without any new signaling and measurements. |
| [R4-2001384](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001384.zip) | Nokia, Nokia Shanghai Bell | Observation 1: While Method 2 (SSB in wide beam and CSI-RS in fine beam from TE) in [2] is best option from the real deployment perspective for ensuring that the UE uses only CSI-RS for beam correspondence, we also see that Method 3 in [2] is viable testing solution.  Observation 2: Potential UE measurement and test requirement enhancements should be discussed and done separately from the ongoing main Rel-16 beam correspondence enhancements.  Proposal 1: Re-use Rel-15 SSB conditions for beam correspondence requirements and test cases based on SSB only |
| [R4-2001490](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001490.zip) | Sony, Ericsson | Observation 1: There is no inherent difference in terms of beam correspondence performance between SSB and CSI-RS under OTA test environment.  Observation 2: The standard deviation of the RSRP estimates coverges quickly when the number of REs is larger than 20 and the SNR = 6 dB.  Observation 3: Rel-15 BC test is declared automatically passed if a UE passes Rel-16 BC test using the same SSB configuration and SNR as in Rel-15.  Proposal 1: Do not configure CSI-RS in P3 for SSB only BC test.  Proposal 2: SSB min SNR level = 6dB in Rel. 16.  Proposal 3: If the Rel-16 SSB BC test is done with the same SSB configuration and side condition as Rel-15, then the UE is allowed to skip the Rel-15 BC test if it passes the Rel-16 SSB BC test. |
| [R4-2001761](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001761.zip) | Huawei, HiSilicon | Observation 1: the current SSB configuration for Beam correspondence test have impact on the UL and DL beam match accuracy.  Observation 2: rough or fine beam selection in P1 procedure is compromise between search time and DL beam selection accuracy, whether refinement shall be fulfilled in P1 procedure in up to UE implementation.  Observation 3: rough beam DL beam search will cause 7dB SNR difference which is defined in TS 38.133.  Observation 4: UE using rough beam in P1 procedure cannot fulfill the RF requirement of beam correspondence defined in the current spec even side condition on SNR is increased by 7dB.  Proposal 1: For SSB only based BC, 3dB degeneration for both bit 1 and bit 0 UEs on Beam correspondence requirement shall be provided.  Proposal 2: the side condition for SSB only based beam correspondence shall be SNR≥13dB which comply with TS 38.133. |

## Open issues summary

The open issues related to Topic #1 can be grouped into the following sub-topics: side conditions of BC based on SSB and the performance difference of BC based on SSB only vs. BC based on CSI-RS only configurations.

### Side conditions of BC based on SSB

**Issue 1-1-1: Whether a BC based on SSB requirement is feasible**

* Proposals
  + Option 1: Yes (4 companies)
  + Option 2: No (2 companies)
  + Option 3: Yes, under certain conditions, e.g. relaxation margin, 3 SSB bursts per grid point, higher SSB SNR (3 companies)
* Recommended WF
  + Convergence between Option 1 and Option 3 is needed

**Issue 1-1-2: SSB min SNR level**

* Proposals
  + Option 1: 6 dB (5 companies)
  + Option 2: 13 dB (1 company)
* Recommended WF
  + Option 1

**Issue 1-1-3: Use P3 CSI-RS?**

* Proposals
  + Option 1: no
* Recommended WF
  + Option 1

**Issue 1-1-4: Tracking CSI-RS min SNR**

* Proposals
  + Option 1: 6 dB
* Recommended WF
  + Option 1

**Issue 1-1-5: Tracking CSI-RS configuration**

* Proposals
  + Option 1: See additional tracking CSI-RS configuration parameters in R4-2000394
* Recommended WF
  + TBD

### Performance difference of BC based on SSB only vs. BC based on SSB and CSI-RS

**Issue 1-2-1: Analysis of performance difference**

* Proposals
  + Option 1: 5 dB
  + Option 2: 3 dB
  + Option 3: 0 dB
* Recommended WF
  + TBD

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Sub topic 1-1:  Issue 1-1-1: Given that CSI-RS with repetition is an optional feature from network perspective, SSB only based BC should be specified. For requirements relaxation compared with Rel-15, we don’t think it is necessary.  Issue 1-1-2 to 1-1-4: Agree with moderator WFs  Issue 1-1-5: If TRS is configured in consecutive slots so that UE can use TRS for beam training instead of SSB, defining SSB-only BC requirement on top of Rel-15 BC will become pointless. Besides, we don’t think all networks would always transmit periodic TRSs with large overhead. UE should also be able to find alternative beams based on SSB in case a serving beam is lost, which cannot always be done by TRS. Moreover, SSB only based BC is critical for UEs in RRC Idle/Inactive which cannot be configured with TRS. Hence, TRS configuration/purpose should be limited to time/frequency tracking and PDCCH/PDSCH demodulation.  Sub topic 1-2:  Issue 1-2-1: This study is not necessary. In Rel-15 side conditions for SSB already assume the UE uses its narrowest beams. (The SSB power per RE is not enough to reach the target SNR with rough beams). UE is expected to meet the same power class peak EIRP and spherical coverage EIRP requirements for any RS of equivalent SNR.  We propose retaining these side conditions to rely on pervious work done in RAN4. |
| Nokia , Nokia Shanghai Bell | Sub topic 1-1-1: When analyzing the feasibility of SSB based beam correspondence UE should be assumed to support SSB based refinement. It seems that in some analyses it has been assumed that the existing Rel-15 UEs should be able to pass the requirements. Since the Rel-15 BC requirements allow the UE to use either SSB or CSI-RS for beam refinement, not all the existing UEs can pass the enhanced Rel-16 BC requirements. When SSB based beam refinement is supported in the UE, SSB based BC should also be possible 🡪 option 1 (yes). If needed, companies may propose changes to the SSB configuration.  Sub topic 1-1-2: We support the recommended WF (option 1). The Rel-15 BC requirements for SSB were defined so that UEs could be able to perform BC based on SSB. Thus, 6 dB (option 1) should be suitable assumption for the Rel-15 SSB based BC requirements as well.  Sub topic 1-1-3: We support the recommended WF (option 1) where P3 CSI-RS is not configured for SSB based BC.  Sub topic 1-2-1: If the UE has implemented needed eBC assumptions, there should not be any performance difference 🡪 option 3 (0dB) |
| Apple | Sub topic 1-1:  Issue 1-1-1: As we have shown in 0791, RRM requirements rely on the SSB, and a beam refinement procedure based on SSB shall take this into account. Additionally, SSB for L1 measurement cannot be QCL-ed with SSB for L3 measurement. Therefore, no Rx refinement for SSB based BC can be assumed. An analysis of performance degradation for SSB-based beam refinement was provided. We can accept Option 3 as a compromise, wherein a relaxation margin is defined.  Sub topic 1-2:  Issue 1-2-1: Option 1 is proposed based on our analysis in 0791. |
| Intel | **Issue 1-1-1: Whether a BC based on SSB requirement is feasible**  Support option 1 and 3. Also support recommended WF ( need convergence btw option 1 and option 3)  **Issue 1-1-2: SSB min SNR level**  Option 1  **Issue 1-1-3: Use P3 CSI-RS?**  Option 1  **Issue 1-1-3: Use P3 CSI-RS?**  Option 1  **Issue 1-1-4: Tracking CSI-RS min SNR**  **Option 1**  **Issue 1-1-5: Tracking CSI-RS configuration**  Option 1  **Issue 1-2-1: Analysis of performance difference**  We think when UE entering RRC connected mode, UE should be able to form narrow beam based on SSB. So the UE should be able to achieve Rel-15 performance. |
| LG Electronics | **Issue 1-1-1: Whether a BC based on SSB requirement is feasible**  Support option 2. RAN4 should consider SSB based BC will be impact to the relaxation of existing peak EIRP and spherical EIRP since the SSB repetition will be impact to air channel consistency. Also there was no P3 CSI-RS QCL info, so RAN4 would be needed to further study for beam refinement procedure from wide beam to narrow beam to keep the rel-15 EIRP levels.  Another issue is the increased OTA test time to satisfy the eBC requirements in Rel-16 when RAN4 define both SSB based BC and CSI-RS based BC. We would like to discuss how to reduce test time.  Our preferred solution is that perform just one eBC test in rel-16. And skip the rel-15 BC requirements even through both SSB and CSI-RS based eBC requirements are specified in rel-16  **Issue 1-1-2: SSB min SNR level**  Option 1  **Issue 1-1-3: Use P3 CSI-RS?**  Option 1, then it is not guarantee the existing rel-15 EIRP requirements for BC.  **Issue 1-2-1: Analysis of performance difference**  We think even if UE be able to form narrow beam based on SSB,  - the SSB resource allocation impossibility of SSB resource for supported number of beam in a slot will be impact to not guarantee the fixed channel state information,  - there was no P3 CSI-RS QCL info  then UE cannot achieve Rel-15 performance. Maybe over 3dB relaxation is needed based on Apple analysis. |
| NTT DOCOMO, INC. | Sub topic 1-1:  Issue 1-1-1: We have the same view as QC and it is our original proposal. We are not sure why additional relaxation is needed as Apple mentioned. Actually, UE would perform Rx beam sweeping when SSB-based RRM measurement is performed. However, it is the same situation as Rel-15 BC since UE would perform Rx beam sweeping even if CSI-RS with repletion is additionally configured. In addition, we are not sure why we should consider wider or narrow beam. In Rel-15, spatial Rx parameter is the same between SSB and CSI-RS with repetition since these RSs are QCLed type-D, so UE Rx beam assumption is the same between Rel-15 and SSB-based BC.  Issue 1-1-2 to 1-1-4: Agree with moderator WFs  Issue 1-1-5: We have similar views as QC. At least NW would configure 1 NZP CSI-RS set for TRS to UE in FR2, so it should be as baseline.  Sub topic 1-2:  Issue 1-2-1: We don’t think such analysis is needed, i.e., there is no performance difference. |
| Samsung | Sub topic 1-1:  Issue 1-1-1: As analyzed in our paper, our preference is Option 2. It is not reasonable for a single UE to have two sets of MOP (peak EIRP + spherical coverage). The beam correspondence for MOP should be relying on the only one RS which can make UE to achieve maximum output power condition, and CSI-RS is the suitable one for MOP. As a compromise we can accept to specify SSB based BC under the condition that SSB based BC is verified with other metric rather than MOP metric |
| OPPO | Issue 1-1-1: Either option 2 or option 3. SSB based BC can be defined but requirements with necessary relaxation need to be considered.  Issue 1-2-1: Agree with the observation in paper 0791 and support option 1. |
| Ericsson | Issue 1-1-1: Option 1  Issue 1-1-2: Option 1  Issue 1-2-1: Option 3 (0 dB) |
| SONY | Sub topic 1-1-1: Yes, the SSB based BC is feasible (Option 1). The UE shall be able to form the beam to the optimal direction regardless of the type of DL reference signal.  Sub topic 1-1-2: We think the SNR of SSB shall be the same as Rel-15, which is 6 dB (Option 1). Please also notice that by using the same side condition as Rel-15 also offers a chance to reduce the test time by skipping the Rel-15 BC test.  Sub topic 1-2-1: We think there is no performance difference between the SSB only BC and the SSB+CSI-RS BC (Option 3). With the same side condition of SSB as in Rel-15, the number of RE and SNR are high enough for the UE to form and select optimized UL beams. |
| Huawei | Sub topic 1-1:  Issue 1-1-1: support option 3. For performance degradation, it does not come from UE implementation but from the test condition. We are open to convergence, the value is from 3-6dB in the contributions, an intermediate value may be acceptable.  Issue 1-1-2: we shall follow TS 38.133, there is 7dB SNR difference between rough and fine beam. 6dB in Rel-15 is designed for P3 procedure.  Issue 1-1-3: agree the proposed WF  Issue 1-1-4: do we need to define SNR for tracking CSI-RS? It is for frequency and timing. It can be up to RAN5.  Issue 1-1-5: do we need to define configuration for tracking CSI-RS? It is for frequency and timing. It can be up to RAN5.  Sub topic 1-2:  Issue 1-2-1: we propose 3dB in our paper, but option 1 may acceptable since we define minimum requirement. One thing to highlight, it is not coming from rough beam and fine beam, it comes from the limitation on test since the TE only provide 1 SSB as we agreed in the last meeting. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*



|  |  |  |  |
| --- | --- | --- | --- |
|  | **Options** | **Supporting companies** | **Recommended WF** |
| **Issue 1-1-1: Whether a BC based on SSB requirement is feasible** | Option 1: Yes | Qualcomm, Nokia, Intel, NTT DOCOMO, Ericsson, Sony (6) | There are 6 companies proposing Option 1, and there are 7 companies proposing either Option 2 or one of the Option 3 variants.  It is recommended to find a compromise based on introducing certain conditions; possible approaches can be Options 3a, 3b, 3c |
| Option 2: No | LGE, Samsung, OPPO |
| Option 3a: Yes with relaxation margin | Apple, OPPO, Huawei |
| Option 3b: Yes with TRS configured as in R4-2000394 | Intel |
| Option 3c: Yes with metric other than MOP | Samsung |
| **Issue 1-1-2: SSB min SNR level** | Option 1: 6 dB | Qualcomm, Nokia, Intel, LGE, NTT DOCOMO, Ericsson, Sony (7) | Option 1 |
| Option 2: 13 dB | Huawei |
| **Issue 1-1-3: Use P3 CSI-RS?** | Option 1: no | Qualcomm, Nokia, Intel, LGE, NTT DOCOMO, Huawei (6) | Option 1 |
| **Issue 1-1-4: Tracking CSI-RS min SNR** | Option 1: 6 dB | Qualcomm, Intel, NTT DOCOMO | Since RAN4 agreed to introduce a tracking CSI-RS configuration during RAN4 #93, is it acceptable to Huawei to proceed with Option 1? |
| Option 2: up to RAN5 | Huawei |
| **Issue 1-1-5: Tracking CSI-RS configuration** | Option 1: See additional tracking CSI-RS configuration parameters in R4-2000394 | Intel | Further discussion is recommended to converge on the purpose of the tracking CSI-RS configuration |
| Option 2: TRS configuration/purpose should be limited to time/frequency tracking and PDCCH/PDSCH demodulation | Qualcomm, NTT DOCOMO |
| Option 3: up to RAN5 | Huawei |
| **Issue 1-2-1: Analysis of performance difference** | Option 1: 5 dB | Apple, OPPO, Huawei | There are 6 companies proposing Option 3, and there are 5 companies proposing either Option 1, 2, or 4  It is recommended to find a compromise based on a non-zero performance difference  NOTE: Issue 1-1-1 and 1-2-1 seem may be linked (i.e. resolving one may help with the other) |
| Option 2: 3 dB | Huawei |
| Option 3: 0 dB (or not necessary) | Qualcomm, Nokia, Intel, NTT DOCOMO, Ericsson, Sony (6) |
| Option 4: >3 dB | LGE |

*Recommendations on WF/LS assignment*

Moderator’s note: a WF is needed to capture the resolution of at least Issue 1-1-1 (note that resolving Issue 1-1-1 can help to resolve Issues 1-1-5 and 1-2-1). Issues 1-1-2 through 1-1-4 are quite stable. A common WF on remaining issues with Rel-16 beam correspondence is needed.

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on remaining issues with Rel-16 beam correspondence | Apple |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | XXX |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Beam correspondence based on CSI-RS

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2000078](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000078.zip) | Qualcomm Incorporated | Observation 1: There is neither a default QCL assumption nor a subsequent UE behaviour in RAN1 when qcl-TypeD of periodic CSI-RS is absent in FR2.  Observation 2: There will be technical implementation issues when P1 CSI-RS is configured with qcl-typeD = ‘none’.  Observation 3: There is no such a test case where a source of qcl-TypeD of periodic CSI-RS is not configured even though it aims to verify UE performances based on configured periodic CSI-RS.  Proposal 1: Parameters for CSI-RS based Beam Correspondence test shall be per Table 1   |  |  |  | | --- | --- | --- | | Parameter | Value | Justification | | P1 CSI-RS periodicity | ~~Alt.1: P1 CSI-RS is configured with [TBD] ms periodicity, the QCL (qcl-TypeD) relation is configured as ‘SSB’~~  Alt.2: P1 CSI-RS is not configured; instead aperiodic P2 CSI-RS can be considered if necessary. If P2 CSI-RS is supported, its qcl-TypeD is ‘SSB’  ~~Alt.3: P1 CSI-RS is configured with [TBD] ms periodicity, the QCL (qcl-TypeD) relation is configured as ‘none’~~ | P1 CSI-RS is not necessary for the test | | P3 CSI-RS repetitions per resource set | Alt. 1: maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand  ~~Alt. 2: 8~~ | Respect UE capability declaration. Besides, UE is not required to meet L1-RSRP accuracy if it is smaller than *maxNumberRxBeam*, and it should not exceed  *maxNumberAperiodicCSI-RS-Resource* as per TS38.133. | | P3 CSI-RS configuration repetition | On |  | | P3 CSI-RS trigger | ~~Alt.1: once P1 CSI-RS is finished~~  Alt.2: once every SSB cycle (20 ms) if P1 CSI-RS is not configured | P1 CSI-RS is not necessary for the test | | Tracking CSI-RS periodicity | reuse Rel-15  60 kHz SCS: 40 slots for CSI-RS resources 1 and 2  120 kHz SCS: 80 slots for CSI-RS resources 1 and 2 |  | | P3 CSI-RS QCL info | ~~Alt.1: Type D to P1 CSI-RS~~  Alt.2:  If P2 CSI-RS is transmitted;  - Type A to TRS  - Type D to P2 CSI-RS  Otherwise;  - Type C to SSB  - Type D to SSB | P1 CSI-RS is not necessary for the test | | P1 CSI-RS QCL info | ~~Alt.1: P1 CSI-RS is transmitted and the QCL relation is configured as ‘SSB’~~  Alt.2: P1 CSI-RS is not transmitted  ~~Alt.3: P1 CSI-RS is transmitted and the QCL relation is configured as ‘none’~~ | P1 CSI-RS is not necessary for the test |   Proposal 2: RAN4 defines CSI-RS based eBC requirement by Method-3 below.  - Method-3: SSB and CSI-RS are present, but SSB’s PSD is back-off by XdB from CSI-RS  - X is either 3 or 6  - CSI-RS SNR is [6]dB  - EIRP requirement in terms of ∆EIRPBC CDF will be defined in such a way that UE relying on SSB-only for beam refinement cannot meet the requirement but UE using CSI-RS can satisfy the requirement |
| [R4-2000271](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000271.zip) | Samsung | Observation 3: Neither Method-1 nor Method-3 is perfect to achieve “CSI-RS only” condition. Method-1 is not feasible and Method-3 may has too high SSB SNR at many AoAs (measurement grids)  Proposal 2: P2 CSI-RS is not necessary for CSI-RS based BC, and Alt.1 is proposed for most of parameters as shown in the table.   |  |  |  | | --- | --- | --- | | **Parameter** | **Value in WF** | **Our proposal** | | P1 CSI-RS periodicity | Alt.1: P1 CSI-RS is configured with [TBD] ms periodicity, the QCL (qcl-TypeD) relation is configured as ‘SSB’  Alt.2: P1 CSI-RS is not configured; instead aperiodic P2 CSI-RS can be considered if necessary. If P2 CSI-RS is supported, its qcl-TypeD is ‘SSB’ [2]  Alt.3: P1 CSI-RS is configured with [TBD] ms periodicity, the QCL (qcl-TypeD) relation is configured as ‘none’ | Alt.1 | | P3 CSI-RS repetitions per resource set | Alt. 1: *maxNumberRxBeam* in UE capability IE of *MIMO-ParametersPerBand*  Alt. 2: 8 | Alt.1 | | P3 CSI-RS configuration repetition | on | 🡨 | | P3 CSI-RS trigger | Alt.1: once P1 CSI-RS is finished  Alt.2: once every SSB cycle (20 ms) if P1 CSI-RS is not configured  \* The test time for Alt.1 is assumed less than or equal to Alt.2 | Alt.1 | | Tracking CSI-RS periodicity | reuse Rel-15  60 kHz SCS: 40 slots for CSI-RS resources 1 and 2  120 kHz SCS: 80 slots for CSI-RS resources 1 and 2 | 🡨 | | P3 CSI-RS QCL info | Alt.1: Type D to P1 CSI-RS  Alt.2:  If P2 CSI-RS is transmitted;  - Type A to TRS  - Type D to P2 CSI-RS  Otherwise;  - Type C to SSB  - Type D to SSB | Alt.1 | | P1 CSI-RS QCL info | Alt.1: P1 CSI-RS is transmitted and the QCL relation is configured as ‘SSB’ [14]  Alt.2: P1 CSI-RS is not transmitted [2]  Alt.3: P1 CSI-RS is transmitted and the QCL relation is configured as ‘none’ | Alt.1 |   Proposal 3: An optimization to Method-3 is proposed to effectively achieve “CSI-RS only” condition by utilizing UE measurement reporting of SS-SINR. The side condition for CSI-RS is SNR=6dB with fixed PSD for all AoAs, and the side condition for SSB is SNR=-3dB with dynamic PSD for each AoA. |
| [R4-2001199](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001199.zip) | LG Electronics | Proposal 1: RAN4 only specified CSI-RS resource based enhanced BC requirements to reduce OTA test time and keep the current EIRP (peak and spherical) in rel-15 without any new signaling and measurements. |
| [R4-2001384](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001384.zip) | Nokia, Nokia Shanghai Bell | Proposal 2: Re-use the Rel-15 CSI-RS conditions for Rel-16 beam correspondence requirements based on CSI-RS only |
| [R4-2001490](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001490.zip) | Sony, Ericsson | Observation 4: Testing CSI-RS only BC through configuring the UE in a BWP without SSBs may not be representative of common real deployments, and it may fail to implement a true CSI-RS only BC test.  Observation 5: Lowering the SNR of SSB can encourage the UE to use CSI-RS for beam selection.  Proposal 4: RAN4 shall identify the scenario where UE can only use CSI-RS for beam selection and decide the test method according to the desired scenario. |
| [R4-2001761](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001761.zip) | Huawei, HiSilicon | Proposal 3: CSI-RS P1 shall be configured to ensure UE would not use SSB measurement as P1 procedure. P2 procedure could be skipped.  Proposal 4: P1 CSI-RS QCL relation is configured as ‘none’.  Proposal 5: For CSI-RS only based Beam correspondence, both periodic and aperiodic CSI-RS shall be provided to the UE, the exact configuration is as in Table 1.   |  |  |  | | --- | --- | --- | | Resource Type | periodic | aperiodic | | Resource Set Config |  |  | | Repetition | off | on | | aperiodicTriggeringOffset | n/a | Depending on UE capability  Periodic and aperiodic CSI-RS are not configured in the same slot | | **Resource Config** |  |  | | nzp-CSI-RS-ResourceId | 0 for resource #0 | Depending on UE capability | | powerControlOffset | 0 | 0 | | powerControlOffsetSS | db0 | db0 | | nrofPorts | 1 | 1 | | cdm-Type | noCDM | noCDM | | Density | 3 | 3 | | nrofRBs | 48 for channel bandwidth ≥ 100MHz  32 for channel bandwidth = 50MHz | 48 for channel bandwidth ≥ 100MHz  32 for channel bandwidth = 50MHz | | qcl-info | none | all AP-CSI-RS resources are TypeD to P-CSI-RS resource#0 | | Periodicity(slots) | Slot80(120kHz) | N/A | | Offset | 8 | N/A |   Proposal 6: the side condition for CSI-RS only based beam correspondence shall be SNR≥ 6dB. |
| [R4-2001777](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001777.zip) | Huawei, HiSilicon | TP for TR 38.831: beam correspondence based on CSI-RS only |

## Open issues summary

The open issues related to Topic #2 can be grouped into the following sub-topics: how to achieve ”CSI-RS only” condition and side conditions of BC based on CSI-RS.

### How to achieve “CSI-RS only” condition

**Issue 2-1-1: Method to achieve “CSI-RS only” condition**

* Proposals
  + Option 1: Method 3 (SSB and CSI-RS are present, but SSB’s PSD is back-off by XdB from CSI-RS)
  + Option 2: Method 4 (decrease SSB power until UE SSB based SS-SINR measurement reporting is within the threshold ≤-3dB)
* Recommended WF
  + TBA

### Side conditions of BC based on CSI-RS

**Issue 2-2-1: P1 CSI-RS configuration**

* Proposals
  + Option 1: P1 CSI-RS is not configured
  + Option 2: P1 CSI-RS is configured with [TBD] ms periodicity, the QCL (qcl-TypeD) relation is configured as ‘SSB’
  + Option 3: P1 CSI-RS is configured with 80 slot (120 kHz) periodicity, the QCL relation is configured as ‘none’
* Recommended WF
  + TBA

**Issue 2-2-2: P2 CSI-RS configuration**

* Proposals
  + Option 1: Aperiodic P2 CSI-RS can be considered if necessary. If P2 CSI-RS is supported, its qcl-TypeD is ‘SSB’
  + Option 2: P2 CSI-RS is not considered
* Recommended WF
  + TBA

**Issue 2-2-3: P3 CSI-RS configuration**

* Proposals
  + Option 1:
    - maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand repetitions per resource set
    - Trigger once every SSB cycle (20 ms) if P1 CSI-RS is not configured
    - If P2 CSI-RS is transmitted, QCL Type A to TRS and Type D to P2 CSI-RS
    - If P2 CSI-RS is not transmitted, QCL Type C to SSB and Type D to SSB
  + Option 2:
    - 8 repetitions per resource set
    - Trigger once P1 CSI-RS is finished
    - QCL Type D to P1 CSI-RS
  + Option 3:
    - All AP-CSI-RS resources are TypeD to P-CSI-RS resource#0
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Sub topic 2-2:  Issue 2-2-1 to 2-2-3: As method 3 or 4 will ensure that UE relies on CSI-RS for BC, “P1 CSI-RS without QCL” doesn’t need to be considered. Not to mention all detailed issues that can be raised by such configuration as observed by R4-2000078. We are okay with either “P2 + P3 CSI-RS” or “P1 QCL’ed with SSB + P3 CSI-RS”, but we slightly prefer the former since aperiodic P2 CSI-RS would be more preferable than periodic P1 CSI-RS in terms of resource efficiency from network perspective. |
| Nokia, Nokia Shanghai Bell | Sub topic 2-1-1: In our view option 1 (Method 3) is feasible option if from the TE perspective it is not seen feasible to use wide beam for SSB and fine beam for CSI-RS in the CSI-RS based BC.  Sub topic 2-2-1: We don’t see that P1 CSI-RS is needed. Therefore, the option1 (P1 CSI-RS is not configured) is our preference. |
| Apple | Sub topic 2-1:  Issue 2-1-1: Option 2 (Method 4) is a reasonable way to achieve the “CSI-RS only” condition  Sub topic 2-2:  Issue 2-2-1: We prefer Option 2 (P1 CSI-RS is configured with QCL Type D to SSB)  Issue 2-2-2: It is not clear to us whether the test equipment can emulate the P2 procedure in a meaningful way; according to our understanding, the test system emulates a flat wave front inside the quiet zone, and it is not clear how the test system can emulate different base station beams. Would it be possible for companies proposing to configure the P2 procedure to clarify this aspect?  Issue 2-2-3: We are fine with Option 2; perhaps it could be useful to rely on the UE capability IE of MIMO-ParametersPerBand, as proposed in Option 1. It is also better to clarify that if P1 CSI-RS is not configured, QCL type D to SSB for L1-RSRP is maintained. |
| Intel | **Issue 2-1-1: Method to achieve “CSI-RS only” condition**  Option 1  **Issue 2-2-1: P1 CSI-RS configuration**  Option 1  **Issue 2-2-2: P2 CSI-RS configuration**  Option 1  **Issue 2-2-3: P3 CSI-RS configuration**  Option 1 |
| LG Electronics | Sub topic 2-1: **Method to achieve “CSI-RS only” condition**  Issue 2-1-1: LGE prefer Option 2 (Method 4)  Sub topic 2-2:  Issue 2-2-1: LGE prefer Option 2 (P1 CSI-RS is configured with QCL Type D to SSB)  Issue 2-2-2: LGE prefer Option 2 (P2 CSI-RS is not configured)  Issue 2-2-3: LGE prefer Option 1 to use maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand. |
| Samsung | Sub topic 2-1:  Issue 2-1-1: support Option 2 (Method 4) since Option 1 (method 3) can not guarantee “CSI-RS only” condition  Sub topic 2-2:  Issue 2-2-1: support Option 2 (P1 CSI-RS is configured with QCL Type D to SSB)  Issue 2-2-2: prefer Option 2 (P2 CSI-RS is not configured) since P2 procedure under RF test environment is not meaningful. TE side antenna is not antenna array and has no beam forming.  Issue 2-2-3: prefer Option 1 to achieve best performance. |
| OPPO | Issue 2-1-1: Prefer Option 1 from reducing test time perspective.  Issue 2-2-1: Prefer Option 2 (P1 CSI-RS is configured with QCL Type D to SSB)  Issue 2-2-2: Prefer Option 2 (P2 CSI-RS is not configured) and our understanding is TE may not be possible to do beam refinement.  Issue 2-2-3: Prefer Option 1, i.e. maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand should be used. |
| Ericsson | General comment: before agreeing a “CSI-RS only” test (configuration), RAN4 should identify the deployment scenario that this test is going to verify. |
| SONY | Sub topic 2-1-1: We think RAN4 shall firstly identify the scenario where UE can only use CSI-RS for beam selection and then decide the test method according to the desired scenario. |
| Huawei | **Issue 2-1-1:**  We provide the method in our paper that P1 CSI-RS is configured and QCL relation shall be none. According to the WF in the last meeting, we can realize CSI-RS only by:   1. Do not configure SSB in the active BWP 2. P1 CSI-RS is configured and the QCL relation is “none”   **Issue 2-2-1:**  Option 3. Only “none” QCL relation can ensure UE do not use SSB for beam correspondence. If we configure P2 CSI-RS directly and QCLed SSB, then actually UE is allowed to use SSB for P1 procedure. We would like to know, if P1 procedure is skipped, whether SSB based beam measurement is being done by the UE? How we ensure on this?  **Attention!!** If adopt option 1 and/or option 2, it actually a Rel-15 test that both SSB and CSI-RS are provided. This is truly from chipset implementation and RAN1 spec understanding.  **Issue 2-2-2:**  Option 2. P2 procedure if for gNB refining beam, it is unnecessary for test mode.  **Issue 2-2-3:**  Our suggestion would be between these options:   * maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand repetitions per resource set * Trigger once P1 CSI-RS is finished * All AP-CSI-RS resources are TypeD to P-CSI-RS resource#0 |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*



|  |  |  |  |
| --- | --- | --- | --- |
|  | **Options** | **Supporting companies** | **Recommended WF** |
| **Issue 2-1-1: Method to achieve “CSI-RS only” condition** | Option 1: Method 3 (SSB and CSI-RS are present, but SSB’s PSD is back-off by XdB from CSI-RS) | Nokia, Intel, OPPO | There seem to be divergent views on this issue.  Alternative 1: Taking the Ericsson and Sony suggestions, is it possible to identify the deployment scenario and to use it to inform the relevant test case parameters?  Alternative 2: Another way forward could be to consider whether an approach based on Option 1 and Option 2 could be considered. |
| Option 2: Method 4 (decrease SSB power until UE SSB based SS-SINR measurement reporting is within the threshold ≤-3dB) | Apple, LGE, Samsung |
| Option 3a: Method 1 (do not configure SSB in the active BWP) | Huawei |
| Option 3b: P1 CSI-RS is configured and the QCL relation is “none” | Huawei |
| Option 4: before agreeing a “CSI-RS only” test (configuration), RAN4 should identify the deployment scenario that this test is going to verify | Ericsson, Sony |
| **Issue 2-2-1: P1 CSI-RS configuration** | Option 1: P1 CSI-RS is not configured | Qualcomm (preferred), Nokia, Intel | Option 2 seems to be acceptable to the majority of companies |
| Option 2: P1 CSI-RS is configured with [TBD] ms periodicity, the QCL (qcl-TypeD) relation is configured as ‘SSB’ | Qualcomm (can accept), Apple, LGE, Samsung, OPPO (5) |
| Option 3: P1 CSI-RS is configured with 80 slot (120 kHz) periodicity, the QCL relation is configured as ‘none’ | Huawei |
| **Issue 2-2-2: P2 CSI-RS configuration** | Option 1: Aperiodic P2 CSI-RS can be considered if necessary. If P2 CSI-RS is supported, its qcl-TypeD is ‘SSB’ | Qualcomm (preferred), Intel | Option 2 seems to be acceptable to the majority of companies |
| Option 2: P2 CSI-RS is not considered | Qualcomm (can accept), Apple, LGE, Samsung, OPPO, Huawei (6) |
| **Issue 2-2-3: P3 CSI-RS configuration** | Option 1a (P2+P3 CSI-RS)   * P1 CSI-RS is not configured * P2 CSI-RS is configured * maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand repetitions per resource set * Trigger once every SSB cycle (20 ms) * QCL Type A to TRS and Type D to P2 CSI-RS | Qualcomm (preferred), Intel | Option 1b seems to be acceptable to the majority of companies |
| Option 1b (P1 QCL’ed with SSB + P3 CSI-RS)   * P1 CSI-RS is configured * P2 CSI-RS is not configured * maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand repetitions per resource set * QCL Type C to SSB and Type D to SSB | Qualcomm (can accept), LGE, Samsung, Apple (can accept), OPPO (5) |
| Option 2a   * 8 repetitions per resource set * Trigger once P1 CSI-RS is finished * QCL Type D to P1 CSI-RS |  |
| Option 2b   * maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand repetitions per resource set * Trigger once P1 CSI-RS is finished * QCL Type D to P1 CSI-RS | Apple (preferred) |
| Option 3:   * maxNumberRxBeam in UE capability IE of MIMO-ParametersPerBand repetitions per resource set * Trigger once P1 CSI-RS is finished * All AP-CSI-RS resources are TypeD to P-CSI-RS resource#0 | Huawei |

*Suggestion on WF/LS assignment*

Moderator’s note: a WF is needed to capture the resolution of Issue 2-1-1, and the remaining Topic #2 issues are quite stable. A common WF on remaining issues with Rel-16 beam correspondence can be used (please see Clause 2.4.1 for the WF assignment).

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: Initial access beam correspondence

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2000012](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000012.zip) | Apple Inc. | Proposal 1: RAN4 shall not define any requirements on initial access.  Proposal 2: RAN4 shall consider whether a requirement is needed to verify UE beam refinement when CSI-RS for P3 procedure is not present. |
| [R4-2000199](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000199.zip) | Qualcomm Incorporated | Observation 1: TRx beam (mis)alignment characteristics between rough beam and fine beam have not been analysed.  Observation 2: How many beam widths UE supports is up to UE implementation.  Observation 3: Which beam width UE uses at a specific moment and during any procedure cannot be specified unless UE should transmit UL channel/signal with the maximum transmission power.  Observation 4: Msg1 based initial access BC property can be verified by SSB-only based Rel-16 eBC, if introduced, unless one wants to introduce a new test specific UE behaviour that forces UE to use rough beam.  **Conclusion: If a UE satisfies SSB-based Rel-16 eBC requirement in connected mode, if introduced, it is considered to satisfy BC during initial access procedure.** |
| [R4-2000858](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000858.zip) | NTT DOCOMO | Observation 2: Beam correspondence for initial access is the subset of the beam correspondence based on only SSB.  Proposal 3: Introduce the requirements on beam correspondence for initial access in Rel-16. The requirements for this enhancement could be discussed based on the discussion on beam correspondence based on only SSB. |
| [R4-2001325](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001325.zip) | Ericsson, Sony | Observation 1: the evaluation of Msg2 reception can be made in a sparse grid. The test time required for verifying the beam correspondace is therefore not excessive.  Observation 2: Both OTA test setup 1 (single AoA) and OTA test setip 3 (two AoAs) from 38.133 are feasible for beam correspondace test in intial access.  Proposal 1: beam correpondence for intial access is critical for system performance and is a SSB-only beam correspondence test. Therefore, it shall be completed within the Rel-16 WI “UE RF enhancement for FR2”.  Proposal 2: verify BC during intial access by measuring the relative spherical coverage and the correlation between PRACH power and msg2 detection capability. |
| [R4-2001384](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001384.zip) | Nokia, Nokia Shanghai Bell | Observation 3: Potential UE requirements for beam correspondence during initial access should be discussed and developed separately from the ongoing main Rel-16 beam correspondence enhancements for BC based on SSB only and BC based on CSI-RS only in RRC\_CONNECTED. |

## Open issues summary

Topic #3 addresses the RAN Plenary guidance and represents a feasibility study of whether a requirement on initial access can be introduced. The open issues consist of the question whether to introduce such a requirement as well as the proposed solutions.

### Feasibility and proposed solutions

**Issue 3-1-1: Whether RAN4 shall introduce a requirement on initial access beam correspondence**

* Proposals
  + Option 1: Yes
  + Option 2: No
  + Option 3: Verify a related “BC property”
* Recommended WF
  + TBA

**Issue 3-1-2: Proposed solutions**

* Proposals
  + Option 1: Verify BC during intial access by measuring the relative spherical coverage and the correlation between PRACH power and msg2 detection capability
  + Option 2: Discuss based on the discussion on beam correspondence based on only SSB
  + Option 3: Msg1 based initial access BC property can be verified by SSB-only based Rel-16 eBC, if introduced, unless one wants to introduce a new test specific UE behaviour that forces UE to use rough beam
  + Option 4: Consider whether a requirement is needed to verify UE beam refinement when CSI-RS for P3 procedure is not present
  + Option 5: Potential UE requirements for beam correspondence during initial access should be discussed and developed separately from the ongoing main Rel-16 beam correspondence enhancements for BC based on SSB only and BC based on CSI-RS only in RRC\_CONNECTED
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Sub topic 3-1:  UE is expected to meet the same power class peak EIRP and spherical coverage EIRP requirements for all channels: PUSCH, PUCCH, PRACH, etc. BC requirements are verified when UE transmits UL with the narrowest transmission beam it can form. In other words, the beam used for Msg1 based BC during initial access will be the same as that for PUSCH based SSB-only BC in RRC Connected state. Hence, we think Msg1 based initial access BC property can be verified by SSB-only based Rel-16 eBC.  If SSB-only BC requirements cannot be defined without relaxations relative to Rel-15, then initial access Msg1 EIRP peak and spherical coverage requirement can be defined separately. Msg1 would have to comply with power class requirements for EIRP |
| MediaTek | **Issue 3-1-1: Whether RAN4 shall introduce a requirement on initial access beam correspondence**  → We support “Option 2: No”. |
| Apple | Sub topic 3-1:  Issue 3-1-1: We propose that RAN4 continues not to define any requirements on initial access. Thus, as a baseline, our preference is Option 2. However, if the issue related to performance differences between BC based on SSB only and BC based on SSB + CSI-RS can be resolved (Topic #1), then we can compromise to Option 3, provided the wording of the requirement does not include initial access.  Issue 3-1-2: The essential beam correspondence property during initial access and IDLE to CONNECTED state transitions is the ability of the UE to refine its UL beam based on SSB without CSI-RS present. Thus, Option 4 is our preference. This is conditioned on the resolution of Topic #1, as we have pointed out in Issue 3-1-1. |
| Intel | **Issue 3-1-1: Whether RAN4 shall introduce a requirement on initial access beam correspondence**  Option 2 |
| LG Electronics | Sub topic 3-1:  Issue 3-1-1: LGE prefer option 2 not to specify the initial access BC since PRACH procedure in RAN1, they consider that FR2 UE do not guarantee beam reciprocity in initial procedure. |
| OPPO | Issue 3-1-1: Prefer option 2 |
| Ericsson | Issue 3-1-1: Option 1. The importance of beam correspondence for the RACH procedure during initial access and preamble coverage was the prime example brought up by RAN1 at the RAN1-RAN4 meeting discussing verification of beam correspondence. Indeed, for operations in the field, it is most important for RACH performance during initial access without means for beam management and should be verified. The conditions are not the same as during connected mode.  The (now completed) test configuration proposed in R4-2001325 has been available for almost a year. Discussing verification during initial access would have been more fruitful than discussing a test – the CSI-RS only -- that does not correspond to a scenario in the field.  Issue 3-1-2: Option 1, verifying the correlation between TX and RX beams for the RACH procedure which is what beam correspondence is all about. |
| SONY | Sub topic 3-1-1: Yes. BC is very critical for initial access since there is no UL beam sweeping available. However, no requirement has been introduced by RAN4 so far. Therefore, we think it is important that RAN4 introduce requirements on the BC in initial access in Rel-16.  Sub topic 3-1-2: To our understanding, only option 1 is feasible to test BC for initial access. Both the Rel-15 BC test (SSB+CSI-RS) and the currently under-discussed Re-16 BC (SSB only and CSI-RS only) are only for RRC connected mode, which cannot guarantee the BC performance in the initial access.  In addition, the proposed test method in option 1 is agnostic for the UE beam pattern since it focuses on the similarity between the Tx and Rx beam patterns. Therefore, it is a more robust test for different UE implementation. |
| Huawei | **Issue 3-1-1 and 3-1-2:**  We support Option 2. Firstly, RF requirement are defined for all channels, and we verifies Tx on PUSCH and RX on PDSCH generally. For PRACH, the beam management consideration may not the same as PUSCH on connected mode, we expects UE access to the network fast enough. Then the BC procedure may different from connected mode. We don't think the similar procedure works for PRACH. If all UE algorithm follow the test procedure provided in R4-2001325, we can see that the initial access delay may be impacted much. Thus not test on PRACH does’t mean UE cannot fulfil the RF requirement, if UE can fulfil requirement PUSCH, then we already verify its RF abilitity. Secondly, there is agreement in RAN2 that if UE donot get response after sending PRACH, UE can choose switch or increase power. The choice is up to implementation. We don’t see how a standard test procedure to adapt for different implementations. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*



|  |  |  |  |
| --- | --- | --- | --- |
|  | **Options** | **Supporting companies** | **Recommended WF** |
| **Issue 3-1-1: Whether RAN4 shall introduce a requirement on initial access beam correspondence** | Option 1: Yes | Qualcomm (separate requirement, assuming >0 dB relaxation margin for SSB-based), Ericsson, Sony (3) | Convergence among companies does not seem evident, with 6 companies preferring Option 2, and 3 companies preferring Option 1. A potential compromise based on Option 3 does not seem to attract much support.  Without a convergent proposal, it may not be possible to pursue this enhancement in Rel-16. |
| Option 2: No | MediaTek, Apple (preferred), Intel, LGE, OPPO, Huawei (6) |
| Option 3: Verify a related “BC property” | Qualcomm (assuming 0 dB relaxation margin for SSB-based), Apple (can accept with >0 dB relaxation margin for SSB-based) |
| **Issue 3-1-2: Proposed solutions** | Option 1: Verify BC during intial access by measuring the relative spherical coverage and the correlation between PRACH power and msg2 detection capability | Ericsson, Sony | An agreement on Issue 3-1-1 is needed as a prerequisite. |
| Option 2: Discuss based on the discussion on beam correspondence based on only SSB |  |
| Option 3: Msg1 based initial access BC property can be verified by SSB-only based Rel-16 eBC, if introduced, unless one wants to introduce a new test specific UE behaviour that forces UE to use rough beam |  |
| Option 4: Consider whether a requirement is needed to verify UE beam refinement when CSI-RS for P3 procedure is not present | Apple |
| Option 5: Potential UE requirements for beam correspondence during initial access should be discussed and developed separately from the ongoing main Rel-16 beam correspondence enhancements for BC based on SSB only and BC based on CSI-RS only in RRC\_CONNECTED |  |

*Suggestion on WF/LS assignment*

Moderator’s note: Issue 3-1-1 is the core issue of this topic, and convergence does not seem evident after the 1st round. If company positions don’t change significantly, it may not be possible to capture any agreement on Topic #3 during this meeting. Further discussion during the 2nd round to seek convergence is recommended.

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: Additional beam correspondence enhancements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2000012](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000012.zip) | Apple Inc. | Observation 2: With increasing Fs, the phase of CC1 steering vector distorts the array response of CC2, and best beam selection optimized for CC1 degrades CC2 performance.  Proposal 3: The Rel-16 requirement on beam correspondence for CA needs to be enhanced to include scope for UL intra-band non-contiguous CA.  Proposal 4: For UL intra-band non-contiguous CA with Fs ≤ 1400, the Rel-15 requirement can be re-used.  Proposal 5: For UL intra-band non-contiguous CA with 1400 < Fs ≤ 2400 the EIRP spherical coverage requirement is relaxed by 0.3 dB.  Proposal 8: RAN4 should discuss further beam correspondence enhancements, including proposed enhancements based UE measurement including RSRP and/or L1-SINR, in the context of further enhancements in Rel-17. |
| [R4-2000079](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000079.zip) | Qualcomm Incorporated | Conclusion: Further additional performance enhancement especially based on UE measurement reports and the corresponding test configuration enhancements will not be discussed under Beam Correspondence Enhancement agenda |
| [R4-2000271](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000271.zip) | Samsung | Observation 4: After introducing L1-SINR reporting, the Rel-16 BC bit-0 UE can be enhanced in terms of saving network resource, test time and so on.  Proposal 4: Introduce L1-SINR reporting in Rel-16 beam correspondence as enhancement to BC bit-0 UE. |
| [R4-2001065](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001065.zip) | Fraunhofer HHI | Observation 1: The peak angles of the boresight beam and of beams close to boresight do not show a significant variance in beam peak direction over frequency when fixed-frequency beamforming weights are used.  Observation 2: Beams steered further away from boresight exhibit greater differences in beam peak direction over frequency when fixed-frequency beamforming weights are used.  Observation 3: Fixed-frequency beamforming weights used for different frequencies affect the direction of both the main lobe and the side lobes.  Observation 4: Any variation in the strength or gain of the main lobes has been masked due to normalization.  Proposal 1: A thorough investigation of the impact of beamforming with DL CA on beam correspondence in terms of spherical coverage performance, regarding both the direction and strength of the beam, should be conducted. |
| [R4-2001232](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001232.zip) | OPPO | Observation 1: Rel-15 beam correspondence is a mandatory feature.  Observation 2: UE can declare support of beam correspondence if it meets RAN4 requirements with or without beam sweeping support.  Observation 3: RAN4 requirements are defined under SINR≥6dB conditions.  Observation 4: UE beam correspondence capability cannot be guaranteed under SINR below 6dB conditions.  Observation 5: Beam sweeping is important to enhance UE beam selection performance in real NW.  Observation 6: The real SINR capability below which beam correspondence is not reliable is UE implementation specific, NW has no knowledge of this.  Observation 7: With the L1-SINR reported, NW could be aware of UE environmental conditions but does not know whether UE beam correspondence capability is reliable or not.  Observation 8: The environmental condition based enhancement can be achieved by UE simply report UL beam sweeping request indication to NW.  Proposal 1: Enhance UE beam selection performance under real NW conditions.  Proposal 2: UE reports the UL beam sweeping request indication when necessary in the NW to realize environmental condition based beam correspondence enhancement. |
| [R4-2001493](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001493.zip) | Sony | Observation 1: Poor SNR and/or poor SINR in the DL may cause the UE not being capable of fulfilling BC without UL beam sweeping.  Observation 2: A UE may in some cases be capable of BC without UL beam sweeping but in other cases not.  Observation 3: Beam correspondence is a dynamic capability in real networks that depends on the network SNR and DL reference signal configuration. It is not enough for the network to only know UEâ€™s beam correspondence capability, regardless of whether the BC UE capability bit is set to 0 or to 1.  Observation 4: It is necessary to have dynamic reporting/signaling from UE in order to ensure the UE performs beam correspondence based on DL reference signals configured by the network.  Proposal 1: Enhancements to beam correspondence measurement reporting is in the scope of Rel-15 beam correspondence WID, and RAN4 should discuss and define it. |

## Open issues summary

The open issues related to Topic #4 can be grouped into the following sub-topics: utilizing the existing UE measurement including RSRP and/or L1-SINR, impact of carrier aggregation, and UL beam sweeping request indication. It is recommended to first identify which of these aspects can feasibly be addressed within the Rel-16 scope before developing detailed solutions.

### Utilizing the existing UE measurement including RSRP and/or L1-SINR

**Issue 4-1-1: Feasibility of utilizing the existing UE measurement including RSRP and/or L1-SINR**

* Proposals
  + Option 1: Proposed enhancement is feasible for Rel-16
  + Option 2: Proposed enhancement is not feasible for Rel-16
* Recommended WF
  + TBA

### Impact of carrier aggregation

**Issue 4-2-1: Feasibility of CA impact**

* Proposals
  + Option 1: Proposed enhancement is feasible for Rel-16
  + Option 2: Proposed enhancement is not feasible for Rel-16
* Recommended WF
  + TBA

### UL beam sweeping request indication

**Issue 4-3-1: Feasibility of UL beam sweeping request indication**

* Proposals
  + Option 1: Proposed enhancement is feasible for Rel-16
  + Option 2: Proposed enhancement is not feasible for Rel-16
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Issue 4-1-1:  Nothing prevents network from utilizing reported measurements for an efficient resource utilization. How to optimize resources based on which measurements are up to network implementation.  Issue 4-2-1:  We recognize the mechanism and agree that it will impact EIRP and EIS too. (see R4-2002147). We would like to discuss if we define radiated mechanism relaxation separately, or roll it into MPR/refsens relaxation.  Issue 4-3-1: Feasibility of UL beam sweeping request indication  As per the endorsed RP-193204 “RAN4 continue discuss the SSB based BC and CSI-RS based BC test cases based on Rel-15 features without consideration on any new signalling or measurement.”, RAN4 is not allowed to discuss issue 4-2-1 |
| Apple | Sub topic 4-1:  Issue 4-1-1: In general, we believe there are a number of potential enhancements to beam correspondence (we have summaried our view in R4-2000024), and it may be more helpful to discuss them as a package in the context of Rel-17 work. With only one quarter remaining to conclude Rel-16, we see a number of open issues that may need to be addressed during Q1 before the proposed enhancement.  Sub topic 4-2:  Issue 4-2-1: Because the current CA BC requirement is written assuming a restriction of UL CA to the case of contiguous 800 MHz, this definition should be extended to apply to the scope of Rel-16 CA work. We see Qualcomm’s comments to Issue 4-2-1 as a helpful way to progress the discussion.  Sub topic 4-3:  Issue 4-3-1: In general, we believe there are a number of potential enhancements to beam correspondence (we have summaried our view in R4-2000024), and it may be more helpful to discuss them as a package in the context of Rel-17 work. With only one quarter remaining to conclude Rel-16, we see a number of open issues that may need to be addressed during Q1 before the proposed enhancement. |
| Intel | **Issue 4-1-1: Feasibility of utilizing the existing UE measurement including RSRP and/or L1-SINR**  Option 1  **Issue 4-2-1: Feasibility of UL beam sweeping request indication**  Option 1 |
| LG Electronics | **Issue 4-1-1: Feasibility of utilizing the existing UE measurement including RSRP and/or L1-SINR**  LGE think the enhancement will be further discuss in rel-17  **Issue 4-2-1:** **Feasibility of CA impact**  Even though UE support FR2 CA, the eBC requirements will be tested for each CC. not to specify the eBC for inter-band CA or intra-band NC CA. For the intra-band contiguous CA, we need further discuss how to impact the legacy EIRP/EIS requirmeents.  **Issue 4-3-1: Feasibility of UL beam sweeping request indication**  LGE think the enhancement will be further discuss in rel-17 |
| Samsung | Sub topic 4-1:  Issue 4-1-1: we think Option 1 is doable. We understand that the remaining time for Rel-16 is limited, but it can be considered as a compromise for BC bit-0 UE. It is controversial how to handle bit-0 UE in Rel-16: one camp is to totally give up bit-0, the other camp is keep exact the same bit-0. To enhance bit-0 UE is a compromised way to proceed.  Sub topic 4-2:  Issue 4-2-1: we see the technical issue caused by CA, and slightly prefer to roll into CA requirements rather than to define a separate relaxation.  Sub topic 4-3:  Issue 4-3-1: We can understand the necessity of UL beam sweeping indication. For a specific AoA, it is not enough for gNB to only know UE’s BC capability. However, according to guidance of RAN plenary, new signaling is not allowed in Rel-16. It can be further discussed in Rel-17. |
| OPPO | Issue 4-1-1: Prefer option 1. Actually this optimisation could be achieved without much impact or complexity, i.e. UE reports the UL beam sweeping request indication when necessary in the NW to realize environmental condition based beam correspondence enhancement.  Issue 4-3-1: Prefer option 1. |
| SONY | Sub topic 4-1-1: Yes, we think it is feasible to utilize the existing UE measurement including L1-SINR  Sub topic 4-3-1: We think technically it is a feasible enhancement for UE to request an UL beam sweeping indication, and the enhancement can be further studied for Rel-16. However, introducing new signaling may need to wait until future release if it is a common understanding in RAN4 that no new signaling can be introduced in Rel-16. |
| Huawei | Issue 4-1-1:  Even L1-SINR introduction which was discussed in RAN1 are only targeting for DL beam measurement, RAN4 shall not extend the concept to beam correspondence. We discuss this topic after related application is clearly agreed in RAN1.  Issue 4-2-1:  We are open to discuss on this issue in the relaxation framework for CA.  Issue 4-3-1:  Option 2, in our understanding, it is not in the range of Rel-16 WI. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*



|  |  |  |  |
| --- | --- | --- | --- |
|  | **Options** | **Supporting companies** | **Recommended WF** |
| **Issue 4-1-1: Feasibility of utilizing the existing UE measurement including RSRP and/or L1-SINR** | Option 1: Proposed enhancement is feasible for Rel-16 | Intel, Samsung, OPPO, Sony | No clear direction is apparent. Further discussion is recommended based on both options. |
| Option 2: Proposed enhancement is not feasible for Rel-16 | Qualcomm, Apple, LGE, Huawei |
| **Issue 4-2-1: Feasibility of CA impact** | Option 1a: Proposed enhancement is feasible for Rel-16 | Apple, Huawei | Further discussion is recommended based on Options 1a, 1b, and 2b. |
| Option 1b: Relaxations can be rolled into existing requirements, such MPR/REFSENS in Rel-16 | Qualcomm, Samsung |
| Option 2a: Proposed enhancement is not feasible for Rel-16 |  |
| Option 2b: Proposed enhancement is not feasible for Rel-16, and eBC shall not be specified for inter-band CA or intra-band NC CA | LGE |
| **Issue 4-3-1: Feasibility of UL beam sweeping request indication** | Option 1: Proposed enhancement is feasible for Rel-16 | OPPO, Intel, Sony (study in Rel-16 and specify in Rel-17) (3) | Option 2 seems to be preferred by the majority of companies. |
| Option 2: Proposed enhancement is not feasible for Rel-16 | Qualcomm, Apple, LGE, Samsung, Huawei (5) |

*Suggestion on WF/LS assignment*

Moderator’s note: after the 1st round only Issue 4-3-1 has the potential to be resolved. Further discussion is recommended for Issues 4-1-1 and 4-2-1. If stable agreements emerge during the 2nd round, it is recommended to capture them in the common WF on remaining issues with Rel-16 beam correspondence can be used (please see Clause 2.4.1 for the WF assignment).

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #5: Beam correspondence capability aspects

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2000012](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000012.zip) | Apple Inc. | Proposal 6: Rel-16 beam correspondence enhancements can be applicable to both Rel-15 beam correspondence types of UEs (bit-0 and bit-1) and are independent of the Rel-15 beam correspondence capability.  Proposal 7: RAN4 should discuss how to define a new capability related to Rel-16 beam correspondence enhancement. |
| [R4-2000271](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000271.zip) | Samsung | Observation 4: After introducing L1-SINR reporting, the Rel-16 BC bit-0 UE can be enhanced in terms of saving network resource, test time and so on.  Proposal 4: Introduce L1-SINR reporting in Rel-16 beam correspondence as enhancement to BC bit-0 UE. |
| [R4-2000858](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2000858.zip) | NTT DOCOMO | Proposal 4: No need to introduce new UE capability for beam correspondence based on SSB only since the beam correspondence performance based on only SSB would be the same as that in Rel-15 except for the time for trying and deciding Rx beam.  Proposal 5: Rel-16 UE shall support the beam correspondence performance based on only SSB as mandatory if UE can set the bit of UE capability on beam correspondence introduced in Rel-15.  Proposal 6: Test applicability rule between Rel-15 and Rel-16 should be clarified. For example, if Rel-16 UE has the UE capability on beam correspondence introduced in Rel-15, UE only performs the test specified in Rel-16 and can skip the test specified in Rel-15. |
| [R4-2001199](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001199.zip) | LG Electronics | Proposal 2: Enhanced Beam Correspondence in rel-16 shall be optional. If UE support rel-16, then, the UE need to meet the enhanced BC requirements with updated side conditions. Then the BC requirement in rel-15 will be skipped as mentioned in WF [2]. The UE only satisfy the CSI-RS based BC requirements. |
| [R4-2001493](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Docs/R4-2001493.zip) | Sony | Observation 5: It is questionable whether the UE BC capability bit is useful for a real network.  Observation 6: A UE can always meet the spherical coverage requirement if the side conditions are properly selected.  Proposal 2: If a UE supports Rel-16 BC and the UE is Rel-15 BC bit-0 UE, it is an invalid scenario and should not be allowed. |

## Open issues summary

The open issues related to Topic #5 can be grouped into the following sub-topics: aspects related to bit0/bit1 UE formulation from Rel-15, aspects related to enhancements introduced in Rel-16, and test case applicability. It is recommended to first resolve the open issues associated with Topics 1 – 4 during the first round of the email discussion.

### Related to bit0/bit1 UE formulation from Rel-15

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 5-1-1: Whether the Rel-15 UE bit0/bit1 BC capability is applicable to Rel-16 enhancements**

* Proposals
  + Option 1: If a UE supports Rel-16 BC and the UE is Rel-15 BC bit-0 UE, it is an invalid scenario and should not be allowed
  + Option 2: Rel-16 beam correspondence enhancements can be applicable to both Rel-15 beam correspondence types of UEs (bit-0 and bit-1) and are independent of the Rel-15 beam correspondence capability
  + Option 3: Introduce L1-SINR reporting in Rel-16 beam correspondence as enhancement to BC bit-0 UE
  + Option 4: Rel-16 UE shall support the beam correspondence performance based on only SSB as mandatory if UE can set the bit of UE capability on beam correspondence introduced in Rel-15
* Recommended WF
  + TBA

### Related to enhancements introduced in Rel-16

**Issue 5-2-1: Whether a new capability for Rel-16 enhanced beam correspondence is needed**

* Proposals
  + Option 1: Yes
  + Option 2: No (mandatory regardless of Rel-15 BC capability)
  + Option 3: No (mandatory if Rel-15 BC capability is bit1)
* Recommended WF
  + TBA

### Test case applicability

**Issue 5-3-1: Test applicability rule**

* Proposals
  + Option 1: Test applicability rule between Rel-15 and Rel-16 should be clarified. For example, if Rel-16 UE has the UE capability on beam correspondence introduced in Rel-15, UE only performs the test specified in Rel-16 and can skip the test specified in Rel-15
  + Option 2: If the Rel-16 SSB BC test is done with the same SSB configuration and side condition as Rel-15, then the UE is allowed to skip the Rel-15 BC test if it passes the Rel-16 SSB BC test
  + Option 3: If UE support rel-16, then, the UE need to meet the enhanced BC requirements with updated side conditions. Then the BC requirement in rel-15 will be skipped as mentioned in WF [2]. The UE only satisfy the CSI-RS based BC requirements
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Moderator’s note: open issues related to Topic #5 are addressed during the 2nd round of discussion and have been moved to Clause 6.5 of this document. Companies are encouraged to share views on Topic #5 issues in Clause 6.5.



### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Issue 5-1-1 to 5-3-1: would like to suggest discussing capability aspects after Rel-16 BC requirements are defined. |
| MediaTek | **Issue 5-1-1: Whether the Rel-15 UE bit0/bit1 BC capability is applicable to Rel-16 enhancements** → We support “Option 2” (# applicable and independent) |
| Intel | **Issue 5-1-1: Whether the Rel-15 UE bit0/bit1 BC capability is applicable to Rel-16 enhancements**  Option 4  **Issue 5-2-1: Whether a new capability for Rel-16 enhanced beam correspondence is needed**  Option 1  **Issue 5-3-1: Test applicability rule**  Option 1 |
| LG Electronics | **Issue 5-1-1: Whether the Rel-15 UE bit0/bit1 BC capability is applicable to Rel-16 enhancements**  LGE prefer option 2 for both bit0/bit1 UE  **Issue 5-2-1: Whether a new capability for Rel-16 enhanced beam correspondence is needed**  LGE think need to capability signaling. So prefer Option 1  **Issue 5-3-1: Test applicability rule**  LGE prefer option 3 |
| NTT DOCOMO, INC. | Issue 5-1-1 and 5-2-1:  At least SSB based BC, we don’t think that new UE capability is needed if there is no performance difference between Rel-15 BC and Rel-16 BC. As mentioned in issue 5-3-1, test applicability rule should be discussed in that case. |
| OPPO | Issue 5-1-1: Prefer option 2  Issue 5-2-1: Prefer option 1  Issue 5-3-1: Prefer option 3 |
| SONY | Sub topic 5-1-1: We think there is no need to define bit 1/0 for Rel-16 (option 1), since the UE BC capability is up to the SINR in real life. Such a capability bit does not provide enough indication to the network.  Sub Topic 5-3-1: We think Option 2 is more reasonable. If the side condition of SSB would be kept the same as in Rel-15 for SSB only BC test, then a UE can pass the Rel-16 BC test should be able to meet Rel-15 BC.  However, if the side condition of SSB become more relaxed for Rel-16 SSB only BC test, the argument above will not be valid anymore, a UE must be tested with all the Rel-16 and Rel-15 BC test. |
| Huawei | Issue 5-1-1: option 2.  Issue 5-1-2: option 2, but it depends on feasibility study on SSB-only.  Issue 5-1-3: we would like to discuss testability issue after we have agreement on the feasibility on SSB-only and CSI-RS only. |
| Apple | Issue 5-1-1: Option 2  Issue 5-2-1: Option 1  Issue 5-3-1: It is useful to conclude the discussions on Topic 1 and Topic 2 to know the exact scope of the Rel-16 requirement and side conditions so that test case applicability rules can be finalized. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |