3GPP TSG-RAN WG2 Meeting #109-e R2-2001936

Online, 24 February – 6 March 2020

**Agenda item: 6.8.2.1**

**Source: Huawei, HiSilicon**

**Title: [Offline-612][POS] Summary on spatial relationship configuration**

**Document for: Discussion and Decision**

# 1 Introduction

This document provide the collection of summary for the following offline discussion.

* [AT109e][612][POS] Spatial relationship configuration (Huawei)

Intended outcome: Summary of agreements on how the spatial relationship is determined for UL-involved cases and how SSB configuration is signalled. Summary in R2-2001936.

Deadline: Wednesday 2020-03-04 1300 CET

This discussion focus on the following two aspects per online agreements:

- How the spatial relation for SRS is determined

- How SSB is signalled and how the signalling can be optimized

# 2 Discussion

## 2.1 Spatial relation for SRS

### Discussion#1: Spatial relation determination for SRS

During the e-meeting, companies provided their views on this, we observed the following three options

* Option 1: Spatial relation is determined by the serving gNB without LMF involvement.
  + Additional supporting procedure may be needed, e.g. Xn exchange of PRS configuration, gNB to retrieve measurement from UE
* Option 2: Spatial relation is determined by the LMF
  + Additional information may be needed in the NRPPa message (e.g. POSITIONING INFORMATION REQUEST)
* Option 3: Spatial relation is recommended by the LMF and determined by gNB
  + Additional information may be needed in the NRPPa message (e.g. POSITIONING INFORMATION REQUEST)

***Companies are encouraged to provide their view on the options or provide other options***

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| Company | Option | Comments |
| Ericsson | Option 1,  Option 3(conditional) | We do not see Option 2 would work. Mainly because.   * Only gNB is allowed to ask UE to provide RRM/Beam Sweep results. Even as part of ECID, UE is only supposed to provide what it has, it should not lead UE to perform additional RRM related measurements. In order to determine spatial relations efficiently, a very recent RRM (Beam Sweep result of Neighbor Beam/cells) is required. Thus, only gNB should be allowed to obtain such information from UE. * It is also possible to configure existing SRS transmission as spatial relation for the new UL SRS transmission; and this is only possible for gNB to configure and determine.   LMF should only trigger positioning calculation related measurements. Otherwise, there is risk if LMF asks UE to (only) perform RRM measurements which should be avoided. It violates the architecture and procedure aspects.  LMF may however as part of positioning procedure involving UL SRS transmission may inform, gNB how many resource sets/ spatial relations etc. is desired and how many cells/TRPs it wants to involve. Depending upon that gNB may determine the spatial relation. If LMF is able to obtain spatial relation without triggering beam sweep results from UE, then it is ok. Otherwise, the recommendation should be more based upon the accuracy QoS; such that how many resources etc. that is desired from LMF perspectives. It should be left to gNB to determine the SRS configuration and spatial relations based upon LMF recommendations.  There should be just one NW node which should determine. There should not be two fragmented decisions; for example, PRS and SRS spatial relation in LMF and SRS (example Rel-15) and SRS (Rel-16) in gNB.  For above reasons, we see gNB which configures UL SRS should determine the spatial relations. |
| Intel | Option 2 | RAN2 agreed for multi-RTT, all information is provided by the LMF as below  Agreements:  1 For Multi-RTT positioning, the DL-PRS information for the candidate TRPs are provided by an LMF to the UE in an LPP Provide Assistance Data message.  2 The time/frequency occupancy of the DL-PRS required in the UL-PRS (SRS) information is provided as part of the DL-PRS assistance data for Multi-RTT positioning. UL-PRS (SRS) information includes an index/pointer to the relevant information in the DL-PRS assistance data (e.g., DL-PRS Resource Set ID/Resource ID).  3 The time/frequency occupancy of the SSBs required in both, DL-PRS and UL-PRS is grouped in a single IE, and a pointer/index is used to reference the required information.  We do not see the reason why different solution is needed for UL only positioning. |
| vivo | Option1 | We thought that both LMF and gNB were able to configure but an interface anyhow is needed between LMF and gNB which will occupied the core network resource and when it is muti-RTT, a large waste of signals of CN.  Also we all knew that gNB already knew the measurement configurations and also the measurement feedback, so it is more reasonable for gNB to decide the SSB.And we don’t need change LPP protocol as well because we couldn’t make a decision on LPP at RAN side.  It is basically only gNB which can ask UE to perform radio resource measurements. Otherwise, it is fundamentally wrong that a CN node is doing so.  Another reason is Each time If systeminfomation of SSB changed, LMF has to be informed and it is not reasonable. |
| Huawei | Option 3 | The neighbouring TRPs to receive SRS is selected by LMF, and the serving gNB cannot do that, so at least some assistance information is needed. How can Option 1 work for example, if serving gNB selects TRP #1, while LMF selects TRP #2? |
| Qualcomm | Option 3 | Given the LCS architecture, only Option2/3 are possible. The LMF manages the overall coordination and scheduling of resources required for the location of a target UE (see TS 23.273). This includes selection of TRPs for measurements.  Since SRS is configured by the gNB, the spatial relation information must be provided as assistance data by an LMF to the serving gNB for a target device. |
| Nokia | Option 3 | This discussion is confusing without sufficient background information on spatial relation information usage. Also, the definition of “spatial relation determination” is not entirely clear. I assume “determination” means the selection of a reference RS (SSB, PRS or CSI-RS) and signaling the specifics of the selected reference RS? According to RAN1 L1 parameters excel, “For positioning purposes, for UL Beam management/alignment towards serving/neighboring cell, support configuration of a spatial relation between a reference DL RS from serving/neighboring cell and the target SRS for positioning”. If this is the case, since the information needs to come from neighboring cells also, the LMF (as it already performs the task of TRP selection) can gather information from neighboring cells/TRP and forward to the serving gNB and let the serving gNB configure the spatial relation info for SRS in the UE. Option 3 fits well to this signaling purpose to us. |
| OPPO | Option 3 | Since LMF is in charge of PRS configuration, it is appropriate for LMF to coordinate spatial relationship, so option 1 via Xn interface is not preferred.  Then considering that the SRS configuration is finally decided by gNB and LMF cannot know the gNB decision on SRS configuration until POSITIONING INFORMATION RESPONSE, logically LMF cannot decide the spatial relationship already at POSITIONING INFORMATION REQUEST. So option 3 seems more straightforward. |
| LG | Option 3 | According to the current procedures, the gNB configures the SRS resources and therefore the corresponding spatial relation information should be determined at the gNB. As Nokia mentioned, the LMF can efficiently collect the SRS configurations and spatial relation information from neighbouring cells to be forwarded to the serving gNB as opposed to the serving gNB over the Xn interface. There is still a possibility that there will be an increase in back and forth request/response signalling over NRPPa between the gNB and LMF, in the event that the requested gNB cannot provide the desired SRS related configuration as recommended by the LMF. Nevertheless, Option 3 is preferred. |

***Summary:***

***Proposal:***

### Discussion#2: Supporting procedure for spatial relation configuration for SRS

In [R2-2001237, R2-2000290], it has also been proposed that gNB should be allowed to retrieve RRM measurements from the UE to help setup the spatial relation information for the neighbouring cells.

**This is a new issue, related to RRC specification. It is not aligned with current procedure, based on this, the procedure will be:**

Step 1: the LMF needs to configure PRS first;

Step 2: the LMF asks the serving gNB to configure SRS;

Step 3: the gNB get PRS-RSRP via RRC;

Step 3: the gNB selects DL-PRS, and informs the SRS configuration +  spatial relationship reference to UE;

Step 4: the gNB forwards the configured SRS to the LMF;

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| But, the DL-PRS can’t support to report the measurement result to gNB. It may lead problem when the DL-PRS are configured for the spatial relation reference signal. Especially, the SSB can’t satisfy the requirement of positioning, such as, the hearability of SSB is worse because the neighbouring cell is so far, or the beam width of SSB can’t satisfy the requirement of beam selecting.  Furthermore, it didn’t need any other measurement if the measurement of DL PRS is essential for RTT, OTDOA.  Observation 3: The measurement of DL-PRS is essential for RTT and OTDOA.  So, we proposal supporting the measurement report RSRP of DL-PRS to gNB for beam selecting when the DL-PRS are configured as the spatial relationship reference signal of SRS.  **Proposal 2: Report the RSRP of DL-PRS to gNB by RRC when the DL-PRS are configured as the spatial relationship reference signal of SRS.** |

***Companies are encouraged to provide their view on the above issue whether it is necessary to report the RSRP of DL-PRS in the RRM measurement***

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| Company | Option | Comments |
| Ericsson |  | The above steps and proposal look ok. |
| Intel | No | It is related to discussion 1. If the spatial relation is determined by the LMF, we do not need this information in the gNB. |
| vivo |  | According current RRC structure that if we need config spacial relation ,we will need config all SRS config, we think add an “optional needM” after IE is possible to avoid repetition, that only the changed part should be configured.for example“UE changed its position，at first the special relation is ssb# 1，then find ssb# 2 is more suitable.” |
| Huawei | No | We think various procedure can be used, including   * UL E-CID, from LMF to extract RRM measurement from gNB reported by UE (if supported) * DL-E-CID, from from LMF to extract RRM measurement from UE directly * Rough UE location estimate based on the serving cell, and beam direction of PRS * Historic PRS measurement   Simply LMF utilize those procedures and recommend PRS/SSB to the serving gNB for it to configure spatial relation of SRS |
| Qualcomm | No | It is related to Discussion #1. E-CID procedures should be sufficient if any RRM measurements are required at the LMF. DL-PRS RSRP is not considered a RRM measurement. |
| Nokia | No | It is also our understanding that DL PRS-RSRP is a positioning measurement and not a RRM measurement. If this measurement is required to do spatial relation configuration in UE then I would think RAN1 would have mentioned this to us. |
| OPPO | No | We see this as non-critical optimization by assuming gNB controlling the SRS spatial relationship configuration. |
| LG | No | Also share the view that we should follow RAN1 guidance on reported positioning measurements. |

***Summary:***

***Proposal:***

## 2.2 SSB configuration signaling

The following options are observed based on the summary of LPP [1].

* Option 1 (R2-2000290): all configuration of T/F occupancy of the SSBs only by RRC.
* Option 2: all configurations of T/F occupancy of the SSBs only by LPP.
* Option 3 (R2-2000290): Parameters of T/F occupancy of the SSBs are configured when the UE requested
* Option 4 (R2-2000991): SSB in LPP and index in RRC (for multi-RTT).
* Option 5 (current CR): Duplication is allowed.

For multi-RTT positioning, we agreed that T/F occupancy for SSB will be grouped in a single IE, and use the pointer to reference the required information

3 The time/frequency occupancy of the SSBs required in both, DL-PRS and UL-PRS is grouped in a single IE, and a pointer/index is used to reference the required information.

In the following, we have separate questions dealing with DL-only, UL-only, and multi-RTT positioning, respectively.

### Discussion#3: SSB configuration for DL-only positioning

In the current running CR, the SSB configuration is under the DL PRS assistance data in the LPP message.

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| *– NR-SSB-Config* The IE *NR-SSB-Config* defines SSB configuration.  -- ASN1START  NR-SSB-Config-r16 ::= SEQUENCE {    trp-ID-r16 TRP-ID-r16,  ss-PBCH-BlockPower-r16 INTEGER (-60..50),  halfFrameIndex-r16 INTEGER (0..1),  SSB-periodicity-r16 ENUMERATED { ms5, ms10, ms20, ms40, ms80, ms160, ...},  ssb-PositionsInBurst-r16 CHOICE {  shortBitmap-r16 BIT STRING (SIZE (4)),  mediumBitmap-r16 BIT STRING (SIZE (8)),  longBitmap-r16 BIT STRING (SIZE (64))  } OPTIONAL, --Need OR  ssbSubcarrierSpacing-r16 ENUMERATED {kHz15, kHz30, kHz60, kHz120, kHz240, ...},  sfn-SSB-Offset-r16 INTEGER (0..15),  smtc-r16 SEQUENCE {  periodicityAndOffset-r16 CHOICE {  sf5 INTEGER (0..4),  sf10 INTEGER (0..9),  sf20 INTEGER (0..19),  sf40 INTEGER (0..39),  sf80 INTEGER (0..79),  sf160 INTEGER (0..159)  },  duration-r16 ENUMERATED { sf1, sf2, sf3, sf4, sf5, ... }  }  }  -- ASN1STOP – *NR-DL-PRS-AssistanceData* The IE *NR-DL-PRS-AssistanceData* is used by the location server to provide DL-PRS assistance data.  -- ASN1START  NR-DL-PRS-AssistanceData-r16 ::= SEQUENCE {  nr-DL-PRS-ReferenceInfo-r16 DL-PRS-IdInfo-r16 OPTIONAL, -- Need ON  nr-DL-PRS-AssistanceDataList-r16 SEQUENCE (SIZE (1..nrMaxFreqLayers)) OF NR-DL-PRS-AssistanceDataPerFreq-r16,  nr-SSB-Config-r16 SEQUENCE (SIZE (0..255)) OF NR-SSB-Config-r16, ...  } |

***Companies are encouraged to provide their views.***

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| Company | Comments |
| Intel | RAN2 has agreed, T/F occupancy is provided in LPP for Multi-RTT. Same should be applied for DL only positioning.  Agreements:  1 For Multi-RTT positioning, the DL-PRS information for the candidate TRPs are provided by an LMF to the UE in an LPP Provide Assistance Data message.  2 The time/frequency occupancy of the DL-PRS required in the UL-PRS (SRS) information is provided as part of the DL-PRS assistance data for Multi-RTT positioning. UL-PRS (SRS) information includes an index/pointer to the relevant information in the DL-PRS assistance data (e.g., DL-PRS Resource Set ID/Resource ID).  3 The time/frequency occupancy of the SSBs required in both, DL-PRS and UL-PRS is grouped in a single IE, and a pointer/index is used to reference the required information. |
| vivo | Keep current implementation |
| Huawei | In LPP |
| Qualcomm | In LPP. SSB Index seems missing in *NR-SSB-Config* above? |
| Nokia | Discussion #3 is also confusing. It lists multiple options for signaling of SSB configuration and it also points out that LPP signaling already allows configuring SSB assistance. Then the question itself is vague and asks for views. I assume the issue here is about what protocol to use for signaling of SSB configuration? Since RAN2 already agreed to use LPP signaling for SSB configuration for multi-RTT and since the current LPP running CR adds SSB configuration to DL-PRS assistance data, we should be able to use LPP signaling for DL-only positioning methods also.  One issue that I am not clear about is, the SSB-Configuration in RRC has a carrierFrequency-r16 but I don’t see a carrier frequency info as part of the SSB-Config in LPP. RAN1 L1 parameters excel says NR-SSB-Config contains the ssbFrequency also. Either NR-SSB-Config should have a carrier frequency or the NR-SSB-Config should be part of NR-DL-PRS-AssistanceDataPerFreq-r16. |
| OPPO | For this Option-2 is sufficient, i.e., LPP is enough, and there is no need for gNB/RRC involvement. |
| LG | The current running CR approach for providing the SSB configuration for DL-only positioning methods via LPP can be maintained. |

### Discussion#4: SSB configuration for UL-only positioning

In the current running CR, the SSB configuration for SRS for positioning is provided in SRS-Config under RRC configuration.

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| SRS-Type2-ResourceSet-r16 ::= SEQUENCE {  srs-Type2-ResourceSetId-r16 SRS-Type2-ResourceSetId-r16,  srs-Type2-ResourceIdList-r16 SEQUENCE (SIZE(1..maxNrofSRS-ResourcesPerSet)) OF SRS-Type2-ResourceId-r16 OPTIONAL, -- Cond Setup  resourceType-r16 CHOICE {  aperiodic-r16 SEQUENCE {  aperiodicSRS-ResourceTriggerList-r16 SEQUENCE (SIZE(1..maxNrofSRS-TriggerStates-1))  OF INTEGER (1..maxNrofSRS-TriggerStates-1) OPTIONAL, -- Need M  slotOffset-r16 INTEGER (1..32) OPTIONAL, -- Need S  ...  },  semi-persistent-r16 SEQUENCE {  ...  },  Periodic-r16 SEQUENCE {  ...  }  },  alpha-r16 Alpha OPTIONAL, -- Need S  p0-r16 INTEGER (-202..24) OPTIONAL, -- Cond Setup  pathlossReferenceRS-r16 CHOICE {  ssb-Index-16 SSB-Index,  csi-RS-Index-r16 NZP-CSI-RS-ResourceId,  ssb-r16 SSB-InfoNcell-r16,  dl-PRS-r16 DL-PRS-Info-r16  } OPTIONAL, -- Need M  ...  }  SRS-ResourceSetId ::= INTEGER (0..maxNrofSRS-ResourceSets-1)  SRS-Type2-ResourceSetId-r16 ::= INTEGER (0..maxNrofSRS-ResourceSets-1)  SRS-Type2-Resource-r16::= SEQUENCE {  srs-Type2-ResourceId-r16 SRS-Type2-ResourceId-r16,  transmissionComb-r16 CHOICE {  n2-r16 SEQUENCE {  combOffset-n2-r16 INTEGER (0..1),  cyclicShift-n2-r16 INTEGER (0..7)  },  n4-r16 SEQUENCE {  combOffset-n4-16 INTEGER (0..3),  cyclicShift-n4-r16 INTEGER (0..11)  },  n8-r16 SEQUENCE {  combOffset-n8-r16 INTEGER (0..7),  cyclicShift-n8-r16 INTEGER (0..5)  },  **...**  },  resourceMapping-r16 SEQUENCE {  startPosition-r16 INTEGER (0..13),  nrofSymbols-r16 ENUMERATED {n1, n2, n4, n8, n12}  },  freqDomainShift-r16 INTEGER (0..268),  freqHopping-r16 SEQUENCE {  c-SRS-r16 INTEGER (0..63)  },  groupOrSequenceHopping-r16 ENUMERATED { neither, groupHopping, sequenceHopping },  resourceType-r16 CHOICE {  aperiodic-r16 SEQUENCE {  ...  },  semi-persistent-r16 SEQUENCE {  periodicityAndOffset-sp-r16 SRS-PeriodicityAndOffset-v16xy, // Editor’s Note: Aperiodic and semi-persisetnt are FFS ...  },  periodic-r16 SEQUENCE {  periodicityAndOffset-p-r16 SRS-PeriodicityAndOffset-v16xy,  ...  }  },  sequenceId-r16 INTEGER (0..65535),  spatialRelation-r16 SRS-SpatialRelationInfo-r16 OPTIONAL, -- Need R  ...  }  SRS-SpatialRelationInfo ::= SEQUENCE {  servingCellId ServCellIndex OPTIONAL, -- Need S  referenceSignal CHOICE {  ssb-Index SSB-Index,  csi-RS-Index NZP-CSI-RS-ResourceId,  srs SEQUENCE {  resourceId SRS-ResourceId,  uplinkBWP BWP-Id  }  }  }  SRS-SpatialRelationInfo-r16 ::= SEQUENCE {  servingCellId-r16 ServCellIndex OPTIONAL, -- Need S  referenceSignal-r16 CHOICE {  ssb-IndexServing-r16 SSB-Index,  csi-RS-IndexServing-r16 NZP-CSI-RS-ResourceId,  srs-SpatialRelation-16 SEQUENCE {  resourceSelection-r16 CHOICE {  type1-r16 SRS-ResourceID  type2-r16 SRS-Type2-ResourceID-r16  }    uplinkBWP-r16 BWP-Id  },  ssbNcell-r16 SSB-InfoNcell-r16,    dl-PRS-r16 DL-PRS-Info-r16  }  }  SSB-Configuration-r16 ::= SEQUENCE {  carrierFreq-r16 ARFCN-ValueNR,  halfFrameIndex ENUMERATED {zero, one},  ssbSubcarrierSpacing-r16 SubcarrierSpacing,  ssb-periodicity-r16 ENUMERATED { ms5, ms10, ms20, ms40, ms80, ms160, spare2,spare1 } OPTIONAL, -- Need S  smtc-r16 SSB-MTC OPTIONAL, -- Need S  sfn-Offset-r16 INTEGER (0..maxNumFFS),  sfn-SSB-Offset-r16 INTEGER (0..15),  ss-PBCH-BlockPower-r16 INTEGER (-60..50) OPTIONAL –- Cond Pathloss  }  SSB-InfoNcell-r16 ::= SEQUENCE {  physicalCellId-r16 PhysCellId,  ssb-IndexNcell-r16 SSB-Index,  ssb-Configuration-r16 SSB-Configuration-r16 OPTIONAL    } |

***Companies are encouraged to provide their views on the signaling above in the current UL-only positioning for SSB configuration***

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| Company | Comments |
| Intel | For UL only, the only choice is to configure SSB in the RRC. |
| vivo | Keep current implementation. |
| Huawei | In RRC. The full configuration of SSB will be provided in RRC as in the current running CR. We assume if LMF recommends gNB to configure SRS spatial relation in the assistance data, the full configuration of SSB should also be included in the assistance data. |
| Qualcomm | For UL-only positioning, only RRC seems possible. The required SSB assistance data can be provided by an LMF to the serving gNB as part of the NRPPa Positioning Information procedure. |
| Nokia | For UL-only positioning, configure UE with SSB-configuration using RRC. This seems aligned to the current RRC running CR already. LMF can assist serving gNB with information about neighbor cells since the LMF already does the TRP selection function and already can gather information from many gNBs using NRPPa procedure. |
| OPPO | Option-1, i.e., all in RRC, as commented above. |
| LG | The current running CR approach for providing the SSB configuration for UL-only positioning methods via RRC can be maintained. |

### Discussion#5: SSB configuration for multi-RTT positioning

As mentioned, we have made the agreement that, for multi-RTT positioning, the reference for UL and DL should be grouped in one IE and for UL and DL component, reference to the resource is given.

***Companies are encouraged to provide their views on the above issue.***

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| Company | Comments |
| Intel | SSB in LPP and index in RRC. RAN2 has agreed it.  The time/frequency occupancy of the DL-PRS required in the UL-PRS (SRS) information is provided as part of the DL-PRS assistance data for Multi-RTT positioning. UL-PRS (SRS) information includes an index/pointer to the relevant information in the DL-PRS assistance data (e.g., DL-PRS Resource Set ID/Resource ID). |
| vivo | 1. For the method of how parameters be grouped in one IE, we proposed that: both LMF and RRC only configure index and T/F occupancy of the SSBs are configured when UE required. We do not limit whether LMF or RRC one component configures, but at one time only once configuration is needed and the other component only need check index to get the whole configurations.   We also need discuss which parameters need be grouped ,otherwise all the multi-RTT related SSB will need group which is not reasonable. |
| Huawei | First preference would be both in LPP and RRC. We do not see a big problem of duplicated configuration, as it can be a corner case and avoided by gNB. Note that for multi-RTT, the best candidate for SRS spatial relation should be PRS, instead of SSB, since PRS is already there and has better coverage than SSB.  Second preference would be only in LPP. In this case, LMF recommends the SSB index, as part of the points mentioned in Discussion #1 and Discussion #2, to the serving gNB, which later forwards the SSB index in SRS configuration, without providing full configuration of SSB. |
| Qualcomm | We should follow previous RAN2 agreements. Whenever possible, assistance data should be provided to a target UE via LPP. |
| Nokia | Go with RAN2 agreements in RAN2#108 on signaling for multi-RTT. So, LPP signaling for DL-PRS assistance including SSB configuration assistance and use of index to point to SSB configuration in DL-PRS assistance for use with any UL related configuration in UE using RRC. |
| OPPO | For this since RRC configuration is needed for SRS, and in order to stick to the principle that SSB configuration should be configured by LPP as answer for #3 above, option-4 can be used, i.e., RRC only contains a pointer. |
| LG | The issue regarding the signalling overhead arises when both UL and DL measurements are required, e.g. in the case of Multi-RTT positioning, resulting in duplication of the same SSB configuration. In line with the previous agreement, we prefer that SSB configuration be grouped in a single IE, while referenced with a pointer/index in another IE. The next step is the signalling delivery mechanism, for providing the group SSB configuration IE and index to the SSB configuration, respectively. Option 4 reaffirms the previous RAN2 agreement whereby LPP is used for carrying the group SSB configuration IE, while RRC carries the index/pointer to the SSB configuration. |

***Proposal 2:***

# 3 Conclusions

TBD

# 4 References

1. R2-2001173 Summary on LPP for aganda 6.8.2.3 Intel Corporation discussion Rel-16 NR\_pos-Core