3GPP TSG RAN WG1 Meeting #106e R1- 21xxxxx

**e-Meeting, August 16th – 27th, 2021**

Agenda Item: 8.4.4

Source: Moderator (OPPO)

Title: Summary#1 of 8.4.4 Other Aspects of NR-NTN

Document for: Discussion and Decision

# Introduction

This document contains a summary of the contributions under AI 8.4.4 at RAN1#106e. This include the topics for RAN1 that should be specified if beneficial and needed as listed in Release-17 NR NTN WID:

* *Enhancement on the PRACH sequence and/or format and extension of the ra-ResponseWindow duration (in the case of UE with GNSS capability but without pre-compensation of timing and frequency offset capabilities) [RAN1/2].*
* *Feeder link switch [RAN2,RAN1]*
* *Beam management and Bandwidth Parts (BWP) operation for NTN with frequency reuse [RAN1/2]*
  + *Including signalling of polarization mode*

# NR-NTN beam management issues

In this section, we discuss beam management related issues and potential enhancements.

## Background

In RAN1#105-e meeting, we have collected the views on the following issues and the moreover extensive discussions were conducted in the last meeting on issue #1, 5 and 7.

* Issue 1: NR BWP is not directly associated with a beam. Thus, when using TCI to change beam from beam 1 to beam 2, it does not trigger NR BWP switching. However, in NTN FRF>1 case, beam switching may result in a BWP switching.
* Issue 2: NR BWP switching in UL and DL are not jointly triggered for FDD. However, in NTN FRF>1 FDD scenario, beam switching may result in a BWP switching in both DL and UL.
* Issue 3: NR dynamic BWP switching requires data scheduling. While in NTN FRF>1 scenario, we may need a fast BWP switching triggering without data scheduling.
* Issue 4: NR BWP switching does not require re-synchronization. However, in NTN FRF>1 scenario, when a satellite beam switching is triggered, UE may need to perform re-synchronization in the switched BWP.
* Issue 5: Since satellite beam switching can be frequent and often highly predictable, mechanisms of configured BWP switching (can be a sequence of BWPs) may be preferred but current NR does not allow it.
* Issue 6: How to deal with BWP switching triggered by bwpInactivityTimer, RA procedure, or simply a need to increase throughput instead of for beam-level mobility.
* Issue 7: NR BWP switching/beam switching is done with UE specific signalling due to UE movement’s. However, in NTN scenario, a satellite BWP/beam switching is common for set of UEs, we may need to a common BWP/beam switching mechanism to save the signalling overhead.
* Issue 8: BWP configuration enhancement
* extending the number of supported BWPs per cell
* cell-specific BWP common configuration
* Issue 9: NR BM framework (TCI state and spatial relations) should be restricted within the same satellite or support the switching of the service links associated with different satellites.
* Issue 10: For NTN, current NR based measurement-based beam management will result in large signaling overhead and long latency for periodic exchange of CSI-RS transmissions and corresponding reporting.

In the last meeting, after 3 rounds of the discussions, we came up with the following FL proposal, which suggests two directions: Alt-1 targets a gNB dominant beam switching for one or a group of UE based on gNB side prediction. Alt-2 targets a UE dominant beam switching based on assistance information.

**FL proposal DP1-1-v5**

For beam management in NR-NTN, support at least one of the following enhancements

* Alt-1: UE BWP/beam switching is triggered by gNB~~relying on prediction~~for one or a group of UE ~~on gNB side~~**to reduce UE measurement effort and/or signaling overhead** .
  + FFS: ~~whether~~ Details on BWP/beam switching ~~can be done~~for a group of UE.
* Alt-2: UE BWP/beam switching is performed by UE ~~automonously~~ autonomously relying on assistance information
  + FSS: details on assistance information

**FL proposal DP3-1:**

For the deployment scenario with multiple beam per cell and frequency reuse >1, NR-NTN should support the following cases for beam measurement performed by a UE:

Alt-1: support beam measurement on multiple RS associated with different beams within a same active BWP.

Alt-2: support beam measurement on multiple RS associated with different beams within across BWPs.

In this meeting, we continue receiving companies’ views on the above issues. The views are summarized in the following table.

Company’s contributions on issue analysis

|  |  |  |
| --- | --- | --- |
| Issue 1 | Spreadtrum | ***Proposal 1: Additional association to map SSB index and BWP index is not needed.*** |
| CATT | **Proposal 1: Support the scenario of initial BWP and active BWP associated with different beams mapping to different geographic areas in NTN.**  **Proposal 2: Supporting beam and BWP switching simultaneously for NTN UE should be clearly defined in UE capability.** |
| QC | **Proposal 1: Support satellite beam specific initial BWPs.**  **Proposal 2: Support the following SSB arrangements**   * **Alt 1: SSBs of all satellite beams in a same cell are transmitted within a same frequency interval and do not overlap in time** * **Alt 2: SSBs of a cell are transmitted in different frequency interval, i.e., within their respective BWPs.**   **Proposal 3: Support signalling of the following configurations in SIB1**   * **initial BWPs of other satellite beams,** * **CORSET#0 of other satellite beams if different from that of the serving beam.** |
| Panasonic | **Proposal 1: RAN1 conclude that no enhancement on the association between BWP and beam for NTN will be introduced.** |
| Ericsson | **Observation 2 Using BWP-BM association to enable a frequency reuse can already be supported by existing NR specification. It is a choice of network configuration and implementation.** |
| Xiaomi | ***Proposal 3: The association between BWP and beam can be supported at least for earth moving case.*** |
| Issue 2 | Spreadcom | ***Proposal 2: BWP switching of UL and DL simultaneously in NTN FRF>1 FDD scenario should be supported.*** |
| Baicells | ***Observation 2: Enhancement on joint trigger of NR BWP switching in UL and DL for FDD is beneficial but not essential.***  ***Proposal 2: Further study on the scheme and benefits of joint trigger of NR BWP switching in UL and DL for FDD.*** |
| Issue 3 | Spreadcom | ***Proposal 3: BWP switching without data scheduling should be supported in NTN FRF>1 FDD scenario.*** |
| Baicells | ***Observation 3: BWP switching without data scheduling can be done only if the resources occupied by the UE in the original BWP are not occupied in the target BWP.***  ***Proposal 3：In NTN, support BWP switching triggering with and without data scheduling.*** |
| Issue 4 | Baicells | ***Observation 4: For BWP switching, time re-synchronization can be avoided by using the same clock source for different beams. Frequency re-synchronization may be necessary.***  ***Proposal 3：In NTN, support BWP switching triggering with and without data scheduling.*** |
| Issue 5 & Issue 7 &  **FL proposal DP1-1-v5** | vivo | ***Proposal 3: Further study the necessity and mechanism of indicating beam switching by group common DCI.***  ***Proposal 4: Both Alt-1 and Alt-2 should be supported for predication based beam switch***  ***Proposal 5: The same signalling framework of beam/BWP switching as NR can be reused in NTN.*** |
| Baicells | ***Observation 5-1: In earth-moving scenario, we acknowledge that beam switching can be frequent and often highly predictable. In earth-fixed scenario, we do not think that beam switching can be frequent and often highly predictable. Meanwhile, we believe earth-fixed mode is more suitable for dedicated beam.***  ***Observation 7-1: In earth-moving scenario, we may need a common BWP/beam switching mechanism (for set of UEs) to save the signaling overhead. In earth-fixed scenario, we may not need a common BWP/beam switching mechanism (for set of UEs). Meanwhile, we believe earth-fixed mode is more suitable for dedicated beam.***  ***Proposal 5-1：Need clarification on earth-moving/ earth-fixed scenario before utilizing mechanisms of configured BWP switching.***  ***Proposal 7-1：Need clarification on earth-moving/ earth-fixed scenario before utilizing mechanisms of common BWP/beam switching (for set of UEs).*** |
| Sony | **Observation 1: in Earth-fixed beam scenario, beam selection in UE side may be needed.**  **Observation 2: in Earth-moving beam scenario, beam selection in at gNB side is needed while at UE side it may be needed.**  **Observation 3: Location-based beam switching can achieve the same results as measurement based at 900 elevation angle.**  **Observation 4: RSRP-based beam switching is better than location based at 70 – 80 degree elevation angles Observation 5: Introducing a fixed linkage between BWP and satellite beam is unnecessary.** |
| CATT | **Proposal 3: Not support UE BWP/beam switching autonomously from RAN1 perspective.**  **Proposal 4: No need to support the configuration of group UEs to do beam switching.** |
| CMCC | ***Proposal 1:*** For beam management in NR-NTN, the motivation of Alt-1 (UE BWP/beam switching is triggered by gNB relying on prediction on gNB side) needs more clarification. |
| Panasonic | **Proposal 2: Further discuss the following prediction-based enhancements of beam management to reduce UE measurement effort and/or signaling overhead.**   * **Enhancement 1: Beam switching according to a sequence of beams configured by RRC** * **Enhancement 2: Information on how ground beam/cell area is defined is broadcast by system information** |
| Ericsson | **Observation 5 According to the current specification, gNB side predictions can already be used to facilitate beam management procedure.**  **Observation 6 BWP switching is not necessarily predictable. BWP/beam switching should be performed dynamically with respect to UE position, interference level, channel condition, etc.**  **Observation 8 No clear scenario or evaluation has been provided to motivate the need for simultaneous beam switching of group of UEs.**  **Observation 9 Complete autonomous UE based beam switching is against the level of control that network should have over the UE behavior.**  **Observation 10 Providing assistance information to UE for the UE autonomous beam/BWP switching imposes signaling overhead and introduces delay.**  Proposal 1 RAN1 to discuss the scope of beam management, i.e., whether NR beam management framework (TCI state and spatial relations) should be restricted within the same satellite or support the switching of the service links associated with different satellites.  Proposal 2 A first satellite providing coverage before a service link switch should assist UEs in RRC connected with signaling of the ephemeris of the second satellite providing coverage after the switch.  Proposal 3 The NR network should be able to indicate the timing of the service link switch to UEs in RRC idle and RRC inactive modes.  Proposal 4 RAN1 to conclude that there is no specification change needed to support same beam layout in BWP#0 and BWP#x (Option 1) and hierarchical beam for BWP#0 (Option 2).  Proposal 5 Regarding Alt-1 in FL proposal DP1-1, the following aspects need to be studied first:  a. Whether any specification work is required for prediction-based beam switching at the gNB side.  b. Clarification of enhancements that address L1 beam switching compared to the enhancements of service link switching.  c. Detailed scenarios that prove the specific issues regarding the predictability of NTN beam switching that requires specification work.  d. Clear scenarios and evaluations (including agreed simulation assumptions) that support the need for simultaneous switching of group of UEs.  Proposal 6 Regarding Alt-2 in FL proposal DP1-1, the following aspects need to be studied first:  a. Investigation of the needed assistance information and assessment of the amount of specification effort.  b. The signaling overhead introduced by providing assistance information versus that of the current switching methods.  c. The signaling delay introduced by providing assistance information versus that of the current switching methods. |
| Huawei | ***Proposal 1****: Support signalling a list of TCI-states based on the predictable serving beams for the UE and the beam switching is triggered by the gNB.*  ***Proposal 2:*** *Consider the possibility of broadcasting satellite beam information in system information for UE dominant beam/BWP switching to reduce beam measurement.* |
| Apple | ***Proposal 2:*** *Support a common BWP/beam switching mechanism for a group of UEs to save signaling overhead.* |
| ZTE | ***Proposal 5:*** *Group-specific beam/BWP switching should be supported to optimize the signalling overhead and performance.*  ***Proposal 6:*** *A common DCI can be considered to carry out beam switching for a group of UEs with low signaling cost.*  ***Proposal 7:*** *Prediction based solution can be considered at least in the implementation to optimize the efficiency for switching.* |
| Xiaomi | ***Proposal 4: Configured BWP switch can be supported.*** |
| InterDigital | ***Proposal 1:*** *UE BWP/beam switching is triggered by gNB (i.e., reuse existing specification).*  ***Proposal 2:*** *no group common BWP/beam switching indication is supported for NTN.* |
| NEC | ***Proposal 1:*** *To reduce measurement effort and retain some control of gNB over beam selection, it is proposed to support:*  ***Proposal 3:*** *Support the L1 filtered measurement report as a notification to gNB for UE initiated configured BWP switching.* |
| Issue 6 | Huawei | ***Proposal 3:*** *The function of bwp\_InactivityTimer should be reconsidered in NR NTN.* |
| NEC | ***Proposal 2:*** *Support the UE initiated timer-based BWP switching to a new default BWP* out of *a sequence of BWPs. UE may be configured with a set of default BWPs and autonomously switch to the next BWP in the set of BWP#0 or next default BWP Id in defaultDLBWPIdSet for fallback.* |
| Issue 8 | Baicells | ***Proposal 7-1：Need clarification on earth-moving/ earth-fixed scenario before utilizing mechanisms of common BWP/beam switching (for set of UEs).***  ***Proposal 8: Support extending the number of supported BWPs per cell and cell-specific BWP common configuration.*** |
| Qualcomm | **Proposal 4: Consider increasing the number of bits for the BWP ID (bwp-Id)**   * **The network can signal the difference between a BWP and a reference BWP to reduce the signalling overhead of BWP configuration.**   **Proposal 5: Support BWP frequency shift through DCI and/or configuration.** |
| Issue 9 | Ericsson | Proposal 1 RAN1 to discuss the scope of beam management, i.e., whether NR beam management framework (TCI state and spatial relations) should be restricted within the same satellite or support the switching of the service links associated with different satellites.  Proposal 2 A first satellite providing coverage before a service link switch should assist UEs in RRC connected with signaling of the ephemeris of the second satellite providing coverage after the switch.  Proposal 3The NR network should be able to indicate the timing of the service link switch to UEs in RRC idle and RRC inactive modes. |
| Issue 10 & **FL proposal DP3-1:** | vivo | *Proposal 2: Support to enhance beam measurement and reporting mechanism for NTN.* |
| Spreadtrum | ***Proposal 6: Beam measurement on multiple RS associated with different beams within a same active BWP and within across BWPs should be supported.*** |
| Baicells | ***Proposal 10: Reduce the dependency of beam management on CSI-RS transmissions and corresponding reporting in NTN.*** |
| CATT | **Proposal 5: Additional enhancement for beam measurement should be justified with clear benefit and motivation.** |
| NEC | ***Proposal 3:*** *Support the L1 filtered measurement report as a notification to gNB for UE initiated configured BWP switching.* |
| OPPO | **Observation 1: In NTN frequency reuse factor greater than 1, legacy L1 CSI-RS based beam management cannot work properly which involves a BWP switching.**  **Proposal 1: support L1 CSI-RS beam measurement enhancement for NTN frequency reuse factor greater than 1.** |
| QC | **Proposal 7: Consider enhancements on radio link monitoring to support efficient reference resource configuration and measurement outside the active BWP.** |
| CMCC | ***Proposal 2:*** For the deployment scenario with multiple beam per cell and frequency reuse >1, at least support beam measurement on multiple RS associated with different beams within a same active BWP (Alt-1).  ***Proposal 3:*** For the deployment scenario with multiple beam per cell and frequency reuse >1, beam measurement on multiple RS associated with different beams within across BWPs (Alt-2) can be further studied. |
| Ericsson | **Observation 12 The “beam measurement on multiple RS associated with different beams within across BWPs” without BWP switching is not supported in the specifications.**  **Observation 13 The feature of “beam measurement on multiple RS associated with different beams within across BWPs”, if introduced, mostly likely would be an optional UE capability. The network cannot rely on the feature for deployment of multiple beams per cell with FRF>1, as network would need to tailor the deployment to the least capable UEs.**  Proposal 7 Regarding DP3-1, the following aspects need to be studied first:  a. The extent of specification impact that is required to introduce measurement gaps for L1 measurements should be evaluated.  b. Comparison between introducing measurement gaps for L1 measurements and utilizing BWP switching to perform the measurements.  c. UE capability for supporting L1 measurements outside active BWP |
| Apple | ***Proposal 1:*** *Consider performing beam measurement either in initial BWP or in different BWPs with BWP switching.* |
| Lenovo | ***Proposal 1: Support both Alt 1 and Alt2. I.e. Multiple RS associated with different beam can be in a same active BWP or across BWPs.***  ***Proposal 2: A trigger state can trigger NZP CSI-RS measurement on multiple BWPs. NZP CSI-RS in different BWPs can be associated with different triggering offset.***  ***Proposal 3: Study how to indexing NZP CSI-RS when multiple NZP CSI-RS are located at different BWPs.***  ***Observation 1: For NTN, current NR measurement-based beam management will result in large signaling overhead and long latency for periodic exchange of CSI-RS transmissions and corresponding reporting.***  ***Proposal 4: Study further methods to perform beam measurements in order to reduce the signaling overhead and avoid long latency.*** |
| InterDigital | ***Proposal 3:*** *beam measurement of multiple RS across BWPs is not needed unless additional beam layout is agreed in Rel-17.* |

Summary:

Issue 1 (beam/BWP association) : 6 companies contributed to this issue. The views are diverged and opposing companies believe that the association is not needed. This topic has not received majority support already in the last meeting, so FL invites the proposing companies to have offline discussion with others. This issue will not be further discussed any more in this meeting.

Issue 2 (BWP switch for UL/DL), Issue 3 (BWP switch without data scheduling), Issue 4(BWP switch with re-sync): for each issue, at most 2 companies contributed to these issues. The issues were discussed in previous meetings already. No contributions from other companies in this meeting. Clearly majority companies don’t think it is an issue. Although there are small amount of companies still think that these issues should be addressed. So FL thinks that there is very small chance that any agreement can be reached. So issue 2,3,4 will not be further considered in this meeting.

Issue 5 (BWP switch relying on prediction), Issue 7 (BWP switch triggering for a set of UE): 13 contributions collected towards these issues. The majority companies think the beam switching is predictable according to the satellite moving trajectory. Thus, a prediction-based beam switch should be considered. The advantage is to reduce the UE measurement and reporting effort. The prediction-based beam switch may lead to two directions as captured in FL proposal DP1-1 of the last meeting, i.e. gNB dominant beam switch and UE dominant beam switch.

For gNB dominant beam switch: the opposing companies think that if the beam switch is triggered by gNB, the gNB can always choose to use the prediction to trigger beam switch. Thus, it is a gNB implementation issue, which does not require further spec enhancement. While proposing companies think that thanks to prediction, the gNB may configure a sequence of beam which follows the trajectory of the satellite movement. Based on the collected views, FL suggests that in this meeting at least to conclude: whether spec enhancement, e.g. gNB configures a sequence of beams based on prediction for the UE to perform beam switch is supported? What are the pros and cons?

For UE dominant beam switch: the opposing companies raised two issues, 1) it will impose signalling overhead and introduce delay; 2) the network will lose the control of the UE behaviour. While the proposing companies propose that the network should provide assistance information, e.g. topology of the surrounding beams, so that the UE can rely on these information to decide which beam should switch to. The advantages are 1) reducing UE measurement effort; 2) avoid beam ambiguity when UE is approchig to multiple footprints and RSRP of multiple beams may varying quickly due to the satellite movement, leading to beam switching hopping between multiple beams. FL suggests that in this meeting to conclude if UE dominant beam swtich based on assistance information is supported, taking into account the argements from both sides.

For BWP switch triggering for a set of UEs: most of the companies think that legacy UE-specific triggering should be reused. Moreover, CMCC points out that the area for a group UE switch is quite limited. FL sees little change to get consensus on this proposal. Thus suggests that BWP triggering for a group of UE is not further considered in this meeting.

Issue 6 (*bwp\_InactivityTimer* functionality): two companies contributed to this issue. This issue was not sufficiently discussed in the last meeting. The function of the *bwp\_InactivityTimer* in the legacy system requires the UE to swtich from the active BWP to default BWP. The comtributing companies point out that this functionality is broken in NTN system. Therefore, FL suggests to discuss this issue to conclude whether there is a problem with *bwp\_InactivityTimer* functionalilty and if so there are the enhancements.

Issue 8 (BWP configuration): 2 companies contributed to this issue. The pointed problems are 1) the number of configured BWPs is to be extended; 2) a common BWP configuration should be introduced in particular for the case where only frequency interval is changed from one BWP configuration to the other. With common BWP configuration, signalling overhead can be saved. FL didn’t see any other contributions against this issue, thus, FL suggests that in this meeting we can discuss and try to conclude whether the issue 8 needs further enhancement.

Issue 9 (BM for inter-satellite): 1 company suggests to discuss the extension of the BM framework for inter-satellite case. Moreover it suggests to indicate an idle UE about the service link switch ahead the RACH procedure. This issue was not sufficiently discussed in the last meeting, thus, FL suggest that in this meeting we discuss and try to conclude whether further enhancement is needed.

Issue 10 (beam measurement): 12 companies contributed to this issue. From the collected views, it seems that for L1-RSRP measurement, current spec only supports target beams to be measured are within the active BWP. The current does not support target beams to be measured outside active BWP. From proposing companies, the target beams are not always in the same active BWP due to FRF>1 deployment. However opposing companies think it is up to gNB implementation, e.g. the gNB may choose to transmit multiple target beams in the same active BWP. On the other hand, one company think L3 RSRP measurement can be used. FL suggests that in this meeting we clarify the following 1) whether L1-RSRP measurement within active BWP and outside active BWP can be supported via gNB implementation; 2) if not, whether both cases should be supported in NTN or whether using L3 RSRP measurement is enough.

## First round discussion

### BWP switch relying on prediction

FL suggests that in this meeting at least to conclude: whether spec enhancement is supported, e.g. gNB configures a sequence of beams based on prediction for the UE to perform beam switch? What are the pros and cons?

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| company | Views and comments |
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FL suggests that in this meeting to conclude if UE dominant beam swtich based on assistance information is supported, taking into account the argements from opposing and proposing companies.

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| company | Views and comments |
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### bwp\_InactivityTimer functionality

FL suggests to discuss this issue to conclude whether there is a problem with *bwp\_InactivityTimer* functionalilty and if so there are the enhancements.

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| company | Views and comments |
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### BWP configuration

The pointed problems are 1) the number of configured BWPs is to be extended; 2) a common BWP configuration should be introduced in particular for the case where only frequency interval is changed from one BWP configuration to the other. With common BWP configuration, signalling overhead can be saved. FL didn’t see any other contributions against this issue, thus, FL suggests that in this meeting we can discuss and try to conclude whether the issue 8 needs further enhancement.

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| company | Views and comments |
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### BM for inter-satellite

Issue 9 (BM for inter-satellite): 1 company suggests to discuss the extension of the BM framework for inter-satellite case. Moreover it suggests to indicate an idle UE about the service link switch ahead the RACH procedure. This issue was not sufficiently discussed in the last meeting, thus, FL suggest that in this meeting we discuss and try to conclude whether further enhancement is needed.

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| company | Views and comments |
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### beam measurement

FL suggests that in this meeting we clarify the following 1) whether L1-RSRP measurement within active BWP and outside active BWP can be supported via gNB implementation; 2) if not, whether both cases should be supported in NTN or whether using L3 RSRP measurement is enough and why.

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| company | Views and comments |
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### Summary of first round

## Second round discussion

### summary of second round

## Third rond discussion

# Signalling of Polarization

## Background

The following agreements were made in RAN1#102e and RAN1#103e, respectively:

Agreement:

Potential enhancements for support of polarisation signalling in NR NTN can consider at least the following:

* Configuration of DL and UL transmit polarization including Right hand and Left hand circular polarizations (RHCP, LHCP)
* Network broadcast DL and UL transmit polarization configuration
* UE polarization capability (RHCP, LHCP, Linear)
* Dependence of polarisation ignalling on deployment scenarios. For example,
  + Resource reuse mode with/without polarization for the beam management enhancement
  + Fixed polarization per cell/beam for polarization reuse and circular polarisation with intra-UE and inter-UE multiplexing (intra-UE and inter-UE) signalling

Agreement:

Indication of polarization information for DL and UL by the network is supported.

* FFS: Signalling details

In RAN1#104-e meeting, we have further achieved the following agreement that at least explicit indication for DL by the network is supported. Moreover, the details of the signalling is to be discussed in this meeting.

Agreement:

Support at least explicit indication of polarization information for DL by the network

* FFS: whether the indication is done by SIB, other RRC ignalling, DCI.
* FFS: Whether separate ignalling is needed for the UL and if so, whether or not a same polarization is indicated for DL and UL

Conclusion:

Discuss the necessity of reporting UE polarization capability considering at least following aspects,

* Deployment scenarios.
* UE implementation aspects with respect to polarization.
* Satellite implementation aspects for switching between polarization states.

Satellite implementation aspects for realizing multiplexing of Ues having different polarization capabilities.

In RAN1#105e meeting, the following agreement was reached.

Agreement:

For explicit indication of polarization information for DL by the network, support indication in SIB

* FFS: Signaling details for indication in SIB

Agreement:

* Polarization information for UL may be indicated in SIB by the network
* UE assumes a same polarization for UL and DL, when the UL polarization information is absent.
* FFS: Signaling details for indication in SIB

In this meeting, we should focus on the signalling design trying to resolve the FFS points from the latest RAN1 agreements.

Company’s contribution

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| vivo | ***Proposal 4: Not support to report UE polarization capability.***  *Proposal 5: Support indicate the polarization information in the following alternatives,*   * *Alt 1: SIB1, for explicit indication* * *Alt 2: SSB transmission, for implicit indication* * ***support to associate SSB transmission with LHCP and RHCP in TDM way.*** |
| NEC | ***Proposal 4:*** *Do not support dynamic polarization indication in Rel-17.*  ***Proposal 5****: Support UE polarization capability indication to gNB.* |
| Spreadtrum Communications | ***Proposal 7: UE reporting polarization capability is not needed.***  ***Proposal 8: Beam specific indication of polarization information for DL by the network should be supported.*** |
| CATT | **Proposal 6: Reporting UE polarization capability is not necessary.** |
| CMCC |  |
| Qualcomm Incorporated | **Proposal 10: Consider at least signalling of polarization per BWP.** |
| OPPO | **Proposal 2: SIB includes DL\_Pol and UL\_Pol parameters which separately select one polarization mode among linear, RHCP, and LHCP.**  **Proposal 3: DL and UL polarization mode is also indicated in UE dedicated RRC.** |
| Samsung |  |
| Ericsson | **Observation 14 In some cases, a UE cannot be expected to reliably detect the used DL polarization.**  [Proposal 8 Support signaling that allows the gNB to configure a UE’s polarization modes including the UE’s receive polarization mode in the DL and the UE’s transmit polarization mode in the UL.](#_Toc79162826)  [Proposal 9 NTN UE should report its polarization capability (RHCP, LHCP, Linear) to the network.](#_Toc79162827) |
| Nokia, Nokia Shanghai Bell | **Proposal 4: The explicit indication of polarization information for DL is carried in an NTN-specific SIB that is broadcast frequently (SIB1 kind of signaling).**  **Proposal 5: The explicit indication of polarization information for UL is carried in an NTN-specific SIB that is broadcast frequently (SIB1 kind of signaling) and which is assumed to be read by the UE prior to performing UL access attempts.** |
| Apple | ***Proposal 3:*** *The downlink polarization per SSB is indicated in SIB.*  ***Proposal 4:*** *UE polarization capability reporting is not supported.* |
| Panasonic | **Proposal 3: Signaling for the following two usages of circular polarization should be supported.**   * **Polarization reuse for inter-cell/beam interference mitigation** * **Polarization multiplexing for throughput improvement**   **Proposal 4: Support indication of polarization information per beam in SIB.**  **Proposal 5: In addition to polarization indication in SIB, the following signaling design should be discussed for operation with polarization reuse:**   * **Polarization indication for beam management** * **Polarization indication for SSB/CSI-RS measurement** * **Polarization indication of target cell/beam for handover**   **Proposal 6: For operation with polarization multiplexing, information on the polarization should be indicated in DCI for scheduling PDSCH/PUSCH.**  **Proposal 7: Support the following UE polarization capability report**   * **Transmission capability of circular polarization (explicitly or implicitly by UE type)** * **Reception capability of dual polarization signals as separate streams** |
| Sony | **Observation 6: Depends on the form factor and complexity of the RF implementation, the supported polarization can vary between UE to UE.**  **Observation 7: To support various types of devices with different polarizations, it is necessary for the network to know the UE polarization capability to ensure a robust link between satellites and UEs.**  **Observation 8: Understanding the UE capability on the supported polarization mode is critical for NTN network deployment. It is also necessary for the NTN network to use the polarization domain, e.g., the gNB can configure multi-user multiplexing on the polarization domain based on UE capability.**  **Observation 9: The UE awareness of gNB polarization of reference signal, e.g., SSB, can improve the beam management performance.**  **Proposal 7: Beam management, e.g., spatial relation, in the NTN network can include the polarization aspect.**  **Proposal 8: Support UE polarization capability reporting, it can be either reported explicitly by the UE or implicitly through the UE measurement and reporting of the DL RS on two orthogonal polarizations.**  **Proposal 5: Support UE polarization capability reporting, it can be either reported explicitly by the UE or implicitly through the UE measurement and reporting of the DL RS on two orthogonal polarizations.**  **Proposal 6: Multi-user multiplexing on the polarization domain based on UE capability is supported.**  **Proposal 7: Support polarization indication per SSB in SIB.** |
| ZTE | ***Proposal 1:*** *The polarization indication can be associated with BWP or SSB using a mapping rule via SIB to save signaling cost.*  ***Proposal 2:*** *The polarization indication for each channel/RS can be supported based on the QCL association with SSB.*  ***Observation 1:*** *The polarization indication per dedicated BWP should be included in UE-specific RRC message if the mapping rule is not defined in SIB.*  ***Proposal 3:*** *The UE polarization capability report can bring benefits to the network scheduling.* |
| FGI, Asia Pacific Telecom, III, ITRI | [Proposal 2For signaling of polarization, a polarization indication carried in SIB1 or DCI format 1\_0 scheduling SIB1 by re-using one bit in another field of the DCI shall be considered.](#_Toc79066461)  [Proposal 3Polarization information shall be divided into serving cell’s polarization and neighbor cell’s polarization.](#_Toc79066462)  [Proposal 4For mobility enhancement, UE shall report whether it is capable of differentiating RHCP and LHCP with circularly or linearly polarized antennas if signaling of polarization is provided.](#_Toc79066463)  [Proposal 5Clarify the UL polarization assumption if the DL polarization information is absent.](#_Toc79066464) |
| Lenovo, Motorola Mobility | ***Proposal 5: UE reporting of its polarization capability is supported.***  ***Observation 2: Defining only a single polarization type for all frequency bands may result in reduced spectrum sharing capabilities, whereas defining multiple polarization types may result in erroneous polarization detection.***  ***Proposal 6: In order to facilitate initial access procedure, one or multiple basic polarization types can be defined for different frequency bands.***  ***Proposal 7: DL Polarization information can be indicated in SSBs to avoid degradation of initial cell search.***  ***Proposal 8: UE polarization capabilities can be indicated explicitly or implicitly during initial access.***  ***Proposal 9: Indication of polarization multiplexing is supported where DCI or TCI state signalling may be used for polarization-based multi-user multiplexing and single-user higher rank transmission.***  ***Proposal 10: Measurement and reporting signaling for polarization is needed for efficient beam switching and handover. CSI-RS may be used for polarization measurements.*** |
| ETRI |  |
| LG Electronics | Proposal 1. The explicit indication of polarization is per SSB(s) and/or per CSI-RS(s) in SIB. |
| Huawei, HiSilicon | ***Proposal 4:*** *If polarization is used for multiplexing, the UE should report its polarization capability. Otherwise, there is no need to report such information.*  ***Proposal 5:*** *Beam-level or UE-level polarization indication should be supported.* |
| Xiaomi | ***Proposal 1: Dynamic indication of polarization is not supported.***  ***Proposal 2: UE polarization capability reporting is supported.*** |
| InterDigital, Inc. |  |

Following the last RAN1 agreement, in this meeting we should continue discussing the polarization signalling design in SIB for DL and UL. According to companies’ contributions, at least the polarization types: RHCP, LHCP and linear should be included in the signalling. Moreover, there are companies propose to indicate the polarization per beam or per BWP. From FL point of view, the polarization signalling in SIB is hard to be associated with BWP. Therefore, a more meaningful follow-up question to discuss is whether the polarization signalling in SIB is associated with beam, e.g. SSB. Thus, FL suggests that in this meeting we discuss the following:

1. For polarization signalling in SIB for DL
   1. the indicated polarizaiton types include RHCP, LHCP and linear
   2. whether the signalling is per cell or per beam, e.g. per SSB index
2. For polarization signalling in SIB for UL
   1. the indicated polarizaiton types include RHCP, LHCP and linear
   2. whether the signalling is per cell or per beam, e.g. per SSB index

In addition to signalling in SIB, there are also proposals suggest that the UE-specific RRC signalling should also be considered for polariziation indication. Moreover, there are proposals to indicate the polarization per channel/RS/BWP. In this meeting, FL suggests that the following can be further discussed:

1. Whether support polariziation signalling in UE-specific RRC
2. If supported, whether the polarizioation signalling is per BWP or per channel/RS.
3. If supported, whether polarization signalling includes other non-serving cell.

From the collected contributions, there are still diverged views on whether polarization multiplexing is to be supported, which links to a follow-up question whether UE polarization capability should be reported to the network. The opposing arguments question about the polariziation multiplexing scenario and believe that it is not feasible or envisagable in practice. However, the proposing views think that the scenario is valid and important for proliferate the system performance. Thus, FL suggest that in this meeting at least we should conclude that if the polarization multiplexing scenario is supported or not. The proposing companies should explain whether it is practically envisagable.

## First round discussion

#### Polarization signalling in SIB

1. For polarization signalling in SIB for DL
   1. the indicated polarizaiton types include RHCP, LHCP and linear
   2. whether the signalling is per cell or per beam, e.g. per SSB index
2. For polarization signalling in SIB for UL
   1. the indicated polarizaiton types include RHCP, LHCP and linear
   2. whether the signalling is per cell or per beam, e.g. per SSB index

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| company | Views and comments |
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#### Polarization signalling in UE-specific RRC

1. Whether support polariziation signalling in UE-specific RRC
2. If supported, whether the polarizioation signalling is per BWP or per channel/RS.
3. If supported, whether polarization signalling includes other non-serving cell.

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| company | Views and comments |
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#### Polarization multiplexing

FL suggest that in this meeting at least we should conclude that if the polarization multiplexing scenario is supported or not. The proposing companies should explain whether it is practically envisagable.

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| company | Views and comments |
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#### Summary of first round

## Second round discussion

## Third round discussion

# Additional Aspects

Aspects on NTN discussed by one or two companies are discussed in this section.

## Background

### RACH Enhancements

Nokia proposed to enable additional SCS scaling factors for all formats defined in TS 38.211 table 6.3.3.1-2 and add one new format (C1) and support restricted set type A for formats defined in TS 38.211 table 6.3.3.1-2. Nokia observed that as GNSS is external to 3GPP, the standard cannot dictate how the UE implements its GNSS solution nor the system chosen (GPS, GLONASS,Galileo, Others). The precision and availability provided by different systems may vary significantly. The full-reliance on GNSS for synchornization and Random Access procedures leaves the 3GPP system implementation dependent on third part systems. Nokia proposed that NTN systems must contain a fall-back conservative solution that allows UE to access the network in case of faulty or malfunctioning GNSS systems.

Samsung observed that a GNSS-aware UE can determine the time and frequency pre-compensation that it should apply when transmitting a PRACH preamble, which improves preamble detection performance for all GNSS-aware UEs. The PRACH guard time for GNSS-aware UEs can be smaller than the PRACH guard time for GNSS-challenged UEs. If PRACH preamble transmissions from GNSS-aware UEs do not interfere with PRACH preamble transmissions from GNSS-challenged UEs, preamble detection performance for all GNSS-challenged UEs improves. Samsung propose that gNB can assign separate PRACH resources to GNSS-aware UEs and GNSS-challenged UEs.

Baicells proposes to increase the SCS of the preamble to resolve the issue of residual frequency offset. Moreover, extended CP is proposed to absorb the timing error.

Nok suggests to add SCS scaling factors for all formats defined in TS 38.211 table 6.3.3.1-2. Also support restrited set type A for

Qualcomm proposes transmit diversity for PRACH transmission with format 2, where the antenna switching is applied for the first half and the second half of the PRACH. The simulation shows about 2 dB gain at 1% miss detection rate.

Switching Point

CP/2

**FL suggestions:**

According to the WID, the PRACH enhancement should be supported if the PRACH issue has been identified. Since the start of the WI, we have not concluded any firm agreement on the PRACH issue. FL invites the companies to provide their views on the pointed PRACH issue and the proposed enhancements.

### Reliance on GNSS system

**Nokia expressed their concern of the stability of the NTN function relying on a third part system.**

**Observation 1: As GNSS is external to 3GPP, the standard cannot dictate how the UE implements its GNSS solution nor the system chosen (GPS, GLONASS, Galileo, Others).**

**Observation 2: The precision and availability provided by different systems may vary significantly.**

**Observation 3: Full reliance on third part GNSS applications leave the 3GPP systems exposed to vulnerabilities that cannot be subject to enhancements or modifications by 3GPP standards or service provider will.**

**Proposal 3: NTN systems must contain a fall-back conservative solution that allows UE to access the network in case of faulty or malfunctioning GNSS systems.**

FL is not sure if the issue is in the scope of the WI as we may assume that the non-GNSS solution is not discussed in R17. But in any case, FL thinks that this topic is highly related to AI 8.4.2. Thus, if there would be any back-up solution, they should be discussed in 8.4.2. So FL invites Nokia to submit their contribution to 8.4.2.

### DL Synchronisation, System Information Acquisition

Qualcomm proposes different SIBs design based on the system information updating rate.

Samsung observed that for a spot beam size that exceeds 250 km, a BS may need to perform a multi-valued Doppler pre-compensation; e.g. it may need to group distinct sets of SSBs using distinct Doppler values for pre-compensation. Indication for multi-Doppler pre-compensation pattern on DL benefits idle UE cell reselection, connected UE handover and connected UE data channel reception. The gNB/satellite can apply different values of Doppler pre-compensation to different SSBs. Samsung proposes that the BWP configuration is extended to indicate the amount of frequency offset to adjust the PRB grid with respect to the default BWP, as the experienced Doppler shifts at different spot beams are different.

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| fc (GHz) | spot beam size (km) | maximum Doppler difference between UEs (kHz) |
| 2 | 50 | 4.185 |
| 2 | 200 | 15.87 |
| 2 | 250 | 19.25 |
| 2 | 300 | 22.33 |
| 2 | ~ 600 | ~ 45 |



 

As suggested in RAN1#104-e and RAN1#105-e meeting, DL synchronization issues should be discussed in AI 8.4.2 to check if it is in the WID scope. Thus this topic is not further discussed in this agenda item.

### Power Control and PUSCH coverage

Samsung proposed that open loop power control, UE should be allowed to predict its own transmission power not only based on DL measurement, e.g., pathloss measurement but also other available information, such as gNB ephemeris and UE trajectory. Samsung proposed closed loop power control should be supported in NTN and a mechanism to disable closed loop power control should be considered.

Qualcomm proposed to support autonomous reduction of MCS for PUSCH at least for cases when UE is power limited and to study the exact triggering condition and indication of the reduced MCS

**FL suggestion:** companies are encouraged to provide views on the issue listed in section 4.1.4.

### HAPS related

CMCC presented the following observations and concluded that HAPS and ATG scenarios are supported by the up to date agreements and no further enhancements are needed.

***Observation 2:*** In order to support HAPS and ATG scenario, the following enhancements should be supported which are essential for ATG and HAPS, and they are also beneficial for satellite application.

* Issue 1: Extend the value range of K1.
* Issue 2: Extend the maximal supported HARQ process number.
* Issue 3: Support satellite ephemeris based on satellite position and velocity state vectors.

***Observation 3:*** Extend the value range of K1 (Issue 1) has been agreed in RAN1#104-e meeting.

***Observation 4:*** Extend the maximal supported HARQ process number (Issue 2) has been agreed in RAN1#102-e meeting.

***Observation 5:*** Support satellite ephemeris based on satellite position and velocity state vectors (Issue 3) has been agreed in RAN1#105-e meeting.

***Observation 6:*** At least from RAN1 perspective, Rel-17 NTN specification can support ATG scenarios.

Softbank presented some views on potential R18 SI scope in R1-2107381. Regarding this contribution, FL thinks that it is out of the WI scope and invites Softbank to have offline discussions with interested companies and the R18 oriented issues are not further discussed in this meeting.

### Channel model

GDCNI presented some issues on the current channel model for NTN in R1-2106999.

***Proposal 1****: Definition of marine and inland river scenes.*

***Proposal 2****: Update Pathloss models for maritime environment.*

***Proposal 3****: Update Pathloss models for inland river environment.*

***Proposal 4:*** *Discuss fast fading models for inland river scenario.*

According to FL’s knowledge, RAN4 is currently working on NTN simulation for calibration phase. The chanel model is based on TR 38.811 and if there is any important issue, RAN4 should be the right place to be informed and be discussed there. For this reason, FL suggests GDCNI to submit there contribution to RAN4 for their information. While discussion on channel model corrections is out of the scope of this agenda item.

## First round discussion

Companies are invited to comment on Additional aspects.

**FL suggestions:**

According to the WID, the PRACH enhancement should be supported if the PRACH issue has been identified. Since the start of the WI, we have not concluded any firm agreement on the PRACH issue. FL invites the companies to provide their views on the pointed PRACH issue and the proposed enhancements.

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| company | Views and comments |
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**FL suggestion:** companies are encouraged to provide views on the issue listed in section 4.1.4.

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| company | Views and comments |
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## Second round discussion

## Third round discussion

# GTW Agreement / Conclusion

# References

[R1-2106594](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2106594.zip) Discussion on other aspects for NR-NTN vivo

[R1-2106704](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2106704.zip) Discussion on beam management and other aspects for NTN Spreadtrum Communications

[R1-2106757](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2106757.zip) Discussion on beam management and other consideration for NTN Baicells

[R1-2106808](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2106808.zip) Discussion on beam management and polarization for NTN Sony

[R1-2106887](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2106887.zip) Remaining issues for NTN Samsung Samsung

[R1-2106970](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2106970.zip) Beam management and other aspects for NTN CATT

[R1-2106999](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2106999.zip) Discussion on channel models for marine and inland river scenes GDCNI

[R1-2107016](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107016.zip) Remaining issues for NR NTN NEC

[R1-2107246](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107246.zip) Discusson on beam management OPPO

[R1-2107290](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107290.zip) Other aspects of NR-NTN FGI, Asia Pacific Telecom, III, ITRI

[R1-2107344](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107344.zip) BWP operation and other issues for NTN Qualcomm Incorporated

[R1-2107381](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107381.zip) Problems of Rel-17 NTN WI from HAPS point of view SoftBank Corp.

[R1-2107402](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107402.zip) Other Aspects for NTN CMCC

[R1-2107463](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107463.zip) Beam management and polarization signaling for NTN Panasonic

[R1-2107541](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107541.zip) Discussions on other aspects of NTN LG Electronics

[R1-2107644](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107644.zip) On other enhancements for NTN Ericsson

[R1-2107675](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107675.zip) Discussion on other design aspects for NTN Huawei, HiSilicon

[R1-2107739](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107739.zip) On Other Aspects of NR NTN Apple

[R1-2107778](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107778.zip) Discussion on additional enhancement for NR-NTN ZTE

[R1-2107921](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107921.zip) Discussion on other design aspects for NTN Xiaomi

[R1-2107946](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2107946.zip) Discussion on other aspects for NTN Lenovo, Motorola Mobility

[R1-2108034](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2108034.zip) On beam management for NTN InterDigital, Inc.

[R1-2108093](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_106-e\Docs\R1-2108093.zip) Further discussion of other aspects for NR over NTN Nokia, Nokia Shanghai Bell