**3GPP TSG-RAN WG2 Meeting #109bis-e R2-2003896**

**Electronic, 20 – 30 April 2020**

**Agenda item: 6.18.2**

**Source: Nokia (Rapporteur)**

**Title: Offline discussion 105: PRN open issues - second round**

**WID/SID: NG\_RAN\_PRN-Core - Release 16**

**Document for: Discussion and Decision**

# 1 Introduction

This document is the report about the second round of the following email discussion

* [AT109bis-e][105][PRN] Open issues (Nokia)

Initial scope: Continue the discussion on PRN open issues, based on R2-2002659

Initial intended outcome: Set of proposals with full consensus agreeable via email, based on the list in Section 4.1 of R2-2002659 (final list to be reflected in R2-2003895)

Initial intermediate deadline (for companies' feedback): Tuesday 2020-04-21 09:00 UTC

Updated scope:

* + - for open issue 8: discuss the possibility to introduce an indication in SIB1 to allow UEs to search other cells on the same frequency
    - for open issue 9: discuss the possibility to signal PCI range(s) per PLMN per frequency vs just per frequency
    - continue the discussion on open issues 11 and 16

Updated intended outcome: summary of the offline discussion with e.g.:

* + - Set of proposals with full consensus, if any (agreeable over email)
    - Set of proposals to discuss in the follow up conference call

Second intermediate deadline (for companies' feedback): Friday 2020-04-24 06:00 UTC

Second intermediate deadline (for rapporteur's summary in R2-2003896): Friday 2020-04-24 10:00 UTC

Proposed agreements in R2-2003896) indicated for email agreement and not challenged until Monday 2020-04-27 12:00 UTC will be declared as agreed by the session chair. For the other ones, the discussion will continue online.

# 2 Discussion

## 2.1 Issue 8: UE behaviour in unlicensed band with non-CAG member cell

**Open issue description:** The UE behaviour in unlicensed band is FFS when the cell belongs to the correct operator but it’s not a CAG member cell.

At RAN2#109 the following was agreed:

For unlicensed spectrum and for a UE with non-empty allowed CAG list, if the highest ranked cell or best cell according to absolute priority reselection rules is a cell which is not suitable due to not broadcasting the selected/registered/equivalent PLMN, the UE with no empty allowed CAG list shall behave according to NR-U agreement. FFS how to handle the case when the cell belongs to the correct operator but it’s not a CAG member cell. (We might come back to this if serious concerns / problems are found with this)

The relevant NR-U agreement is captured in the following way in 38.304:

“For operation with shared spectrum channel access, if the second highest ranked cell on this frequency also does not have a PLMN being equivalent to the registered PLMN, the UE may consider this frequency to be the lowest priority for a maximum of 300 seconds.”

During the online discussion of R2-2002659 it was concluded that a selection from the following options should be made:

* **Option A) Follow the NR-U behaviour:**   
  In unlicensed band when the highest ranked cell or best cell is not suitable due to belonging to the correct operator, but it is not a CAG member cell, the UE shall not consider this cell as candidate for reselection for a maximum of 300 seconds. If the second highest ranked cell on this frequency is not suitable due to belonging to the correct operator, but it is not a CAG member cell, the UE may consider this frequency to be the lowest priority for a maximum of 300 seconds.
* **Option B) Follow the licensed behaviour:**   
  In unlicensed band when the highest ranked cell or best cell is not suitable due to belonging to the correct operator, but it is not a CAG member cell, the UE shall not consider this cell and other cells on the same frequency, as candidates for reselection for a maximum of 300 seconds.
* **Option C)** Introduce a new flag in SIB1 that indicates whether the UE may (or shall not) consider other cells on the same frequency, as candidates for reselection.

**Question 1: Which option(s) do you prefer?**

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| **Company** | **Preferred** | **Comment** |
| Samsung | Option B | In the option the NRU principle is followed if the highest ranked cell or best cell is not suitable due to NOT belonging to the correct operator. So, the UE is allowed to reselect another cell on the same frequency. When the UE finds the second highest ranked cell on this frequency is not suitable due to belonging to the correct operator, but it is not a CAG member cell, the UE may consider this frequency to be the lowest priority for a maximum of 300 seconds.  This option still allows the UE look of cells on this frequency after 300 seconds. During the web session discussion, some operators expressed views of considering CAG deployment on unlicensed frequency with lower priority. Given this operator feedback, we prefer not to optimise the scenario and follow Option B which is simple and less specification impacts |
| Huawei | Option A | I don’t remember having an agreement for licensed regarding “the best cell is not suitable due to belong to the correct operator but it is not a CAG member cell”. Therefore the UE behaviour for licensed spectrum should also be clarified.  In LTE CSG, there is:  *If the highest ranked cell or best cell according to absolute priority reselection rules is a CSG cell which is not suitable due to not being a CSG member cell, the UE shall not consider this cell as candidate for cell reselection but shall continue considering other cells on the same frequency for cell reselection.*   1. For licensed:   We see no motivation of deviating from the CSG behaviour. If the best cell is not suitable due to not being a CAG member, other cells should not be excluded.   1. For unlicensed:   We think the behaviour can be the same with licensed, i.e. other cells should not be excluded.  However, it’s also ok for us to respect the agreements of NR-U, that is, take intra-frequency interference into account, only consider the strongest and second strongest cell on a frequency, other cells are excluded. |
| CATT | Option A | Option A is preferred as,   1. Considering other cells on the same frequency will improve the success rate of cell reselection. 2. Camping on the second highest ranked cell should have less inter-cell interference than camping on the original serving cell as cell reselection is to find a better cell than serving cell. Therefore inter-cell interference should not be a big concern here. 3. Moreover, agree with Huawei that it is to be clarified what the UE behaviour for licensed spectrum for the case “the best cell is not suitable due to belong to the correct operator but it is not a CAG member cell” |
| China Telecom | Option A | We want the frequency deployment strategy of CAG is flexible for operators, no matter licensed or unlicensed spectrum. There might be more than one CAG deployment in the same frequency within one operator. So option A is more reasonable for us. |
| Vodafone | Option A | Option a allows more flexibility |
| Intel | Option A | Option A follows the CSG concept where it tries to give the UE opportunities to camp in its member cells.  On the other hand, Option B follows the best cell concept. Furthermore, the cells belong to the same PLMN/operator can coordinate properly to reduce such possibility that access is not possible in a cell for a CAG UE.  As on using IFRI, we do not think we should extend the use of the indication for this case since it is typically use for initial deployment where some of the cells in a frequency are not ready for use (hence it is linked with cell barring in the MIB). As on introducing a new IFRI in SIB1 for this case, it seems like an overkill to do it just for this case.  Hence if the operator sees a need for such flexibility and it is for a PLMN where coordination between cells are possible either from radio resource or cell deployment, we should just go for Option A for unlicensed operation. |
| Futurewei | Option A | Option A would allow an operator to deploy multiple CAGs on the same carrier frequency. |
| Ericsson | Option B (or option C) | Agree with Samsung that option B also follows the principle of NR since other cells are considered when the highest ranked cell belongs to a different operator.  We prefer option B but we can accept option C as a compromise. Our understanding is that the UE will anyway need to read SIB1 to determine the PLMN ID of the cell so the indication in option C would not cause any extra SIB1 readings. The indication could e.g. be put on the top-level in SIB1:  SIB1-v16xy-IEs ::= SEQUENCE {  idleModeMeasurements-r16 ENUMERATED{ffs} OPTIONAL, -- Need N  posSI-SchedulingInfoList-r16 PosSI-SchedulingInfoList-r16 OPTIONAL, -- Need R  nonCriticalExtension SEQUENCE {} OPTIONAL  cag-intraFreqCellReselection ENUMERATED {allowed}  OPTIONAL, -- Need R  }  ***cag-intraFreqReselection***  Indicates whether the UE is allowed to select/reselect to other intra-frequency cells when the highest ranked cell belongs to the selected/registered PLMN or an equivalent PLMN but is not a CAG member cell.  Extending the interpretation of the IFRI bit in MIB would also be acceptable to us if other companies instead prefer that option.  We also agree with Huawei that the licensed spectrum case also need to be discussed. |
| Qualcomm | Option C | There are good arguments on both sides and there is not enough data from the field to indicate which view is right (given that neither NR-U nor CAG are deployed today). Adding a bit looks like a good choice. |
| Apple | Option A | Agree with CATT and we believe that there is better success rate for cell reselection. |
| Nokia | Option A | In unlicensed bands selecting not the best cell was found to be acceptable during NR-U work.  Option C has the problem that it does not help when non-CAG cells are deployed in an area (it cannot be assumed that all non-CAG gNBs will support this optional enhancement). |
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**Summary:**

## 2.2 Issue 9: PCI values for CAGs

**Open issue description:** FFS whether PCI values for CAGs are signalled per PLMN per frequency or no new ASN.1 IEs are introduced in Rel-16 for signalling of PCI values for CAGs

During the online discussion of R2-2002659 it was concluded that a selection from the following options should be made:

* **Option A** (used to be option 2 in R2-2002659): Signal PCI range(s) per PLMN per frequency. Number of ranges FFS.
* **Option B** (used to be option 4 in R2-2002659): Signal PCI range(s) per frequency as a list of blacklisted/whitelisted cells (no changes required to ASN.1 and NR-U CRs are the baseline).

**Question 2: Which option(s) do you prefer?**

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| **Company** | **Preferred** | **Comment** |
| Samsung | Option A | This is simple with less signalling overhead |
| Huawei | Option A | As Qualcomm indicated in this email thread, Option B was ruled out by the online discussion:   * Discuss in followup offline [105] the possibility/feasibility to signal PCI range(s) per PLMN per frequency vs just per frequency   And the two options on the table should be “per PLMN per frequency” and “per frequency”.  We think the granularity of PLMN makes sense, because in RAN sharing cases, a physical cell may broadcast multiple PLMNs, some of which contains CAG IDs while others are just for public network. |
| CATT | Option A | Agree with Huawei |
| China Telecom | Option A | Agree with Huawei. |
| Vodafone | Option A | We would have preferred further Granularity such as PCI per CAG list |
| Intel | Option A | This provides a good compromise in terms of overhead between per CAG ID and per frequency |
| Futurewei | Option A | It addresses CAG use cases better. |
| Ericsson | Option A | I think the two options agreed to be discussed were:   1. PCI range(s) per PLMN per frequency; 2. PCI range(s) per frequency   The option of using blacklisted/whitelisted cells was ruled out in the online session due to some technical problems as I understood it.  Regardless of the option we choose, we should confirm that the PCI range is optional. |
| Qualcomm | Option A | No strong views on the two variants: “per PLMN per freq” vs “per freq”.  As we stated in reflector email (and several companies seem to agree), the whitelist/blacklist option was ruled out in online discussion. |
| Apple | Option A | Agree with Huawei |
| Nokia | Option B | We think that PCI lists per frequency are enough, as UE specific priorities provided in *RRCRelease* can be used to provide PLMN and/or CAG specific reselection priorities. Legacy (pre-Rel-16) RAN sharing (NR and LTE) works without PLMN specific PCI lists. |
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**Summary:**

## 2.3 Issue 11: Optionality to support reporting about the npn-IdentityInfoList

**Open issue description:** It is FFS if all Rel-16 are required to be able to report the *npn-IdentityInfoList*

At RAN2#109e the following was agreed

4.1: Extend the current measurement reporting procedures to include NPN information to support ANR. (It is FFS if it is mandatory for all Rel-16 UEs to support it.)

4.2: The CAG ID/SNPN NID information shall be added into the CGI-InfoNR. (It is FFS if it is mandatory for all Rel-16 UEs to support it.)

During the email discussion of this issue (see R2-2002659) the following options were discussed

* **Option A:** Reporting about the *npn-IdentityInfoList* is mandatory for all Rel-16 UEs
* **Option B:** Reporting about the *npn-IdentityInfoList* is mandatory for all NPN-capable UEs, but optional for non-NPN capable UEs (separate capability indication about CGI reporting for NPN may be needed)
* **Option C:** Reporting about the *npn-IdentityInfoList* is mandatory for all NPN-capable UEs, and not supported by non-NPN capable UEs (separate capability indication about NPN may be needed)

During the email discussion (see R2-2002659) most of the companies supported option C, but companies that do not support option C had the following technical concerns

* ANR reporting is important
* There is a justification for option A that “the UE reports all the broadcast NCGI(s)/ECGI(s) to the serving cell NG-RAN node reporting about broadcasted IDs” is a requirement in 38.300.
* There is a comment that if reporting about NPN information is not mandatory then an AS level capability indication is needed. (See also issue 18).

**Question 3: Which option do you prefer?**

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| **Company** | **Answer** | **Comment** |
| Samsung | Option C | It is not desirable that non-NPN capable UEs are forced to report *npn-IdentityInfoList*. Based on the agreement reached for support of emergency calls for non-NPN capable UEs, it is understood that these UEs are not required to read the NPN information. Further, this avoid AS level capability indication i.e. less specification impact. |
| Huawei | C | We agree that ANR reporting is important, but note that the existing CGI related capabilities (without NPN involved) in 38.306 are mandatory with signalling, which is basically equal to optional.  Besides, we don’t think answering “Option C” to this question directly leads to adding an AS capability.  The AMF has a way of knowing UE’s NPN capability by SNPN subscription information and the "CAG Supported" in NAS signalling. The mobility restriction list sent from AMF to NG-RAN node contains the serving NID and allowed CAG list, therefore NG-RAN node can also acquire UE’s NPN capability information. |
| CATT | Option C | We should take the same principle as that for support of emergency calls for non-NPN capable UEs. We understand the principle is that non-NPN capable UE should not be required to do anything related to NPN feature |
| China Telecom | Option C | We think non-NPN capable UE does not need to read and report NPN list. |
| Vodafone | Option C | This is the sensible way forward all NPN-capable UEs report *npn-IdentityInfoList* and the UEs which do not have that capability don’t! |
| Intel | Option C | We should follow the general principle that UE not capable of a feature does not need to process the signalling of that feature other than its presence.  For ANR reporting, it is a best effort mechanism where it can be left to other UEs capable of NPN can provide.  On the need of AS capability, we do not understand the relation between the need of this and that, since RAN will know whether the UE is CAG capable from the mobility restriction (containing the allowed CAG list). For SNPN, it can only camp and access on cells belonging to its registered SNPN. |
| Futurewei | Option C | We don’t think non-NPN capable UEs should be required to read npn-IdentityInfoList. |
| Ericsson | Option C | Agree with e.g. Samsung and CATT, this option is consistent with the agreement reached for emergency calls. |
| Qualcomm | Option B/A | Having this flexibility is important. We did not see any response to the scenario we mentioned in previous discussion:   * CAG is deployed in an area where CAG UEs always stay in CAG coverage, or are configured to connect only to CAG * Macro-cells in the area still need to ensure non-CAG UEs are not handed over to the CAG * The only way for the macros to discover the CAG cells and prevent handovers to the CAG cells is by ANR performed by non-CAG-capable UEs.   We thank Huawei for exploring this issue, but their answer did not fully answer the problem.  Also, the reading of CGI is not a CAG specific feature (irrespective of which IE of SIB1 carries the CGI) and is required by 38.300 that UEs be able to report all CGIs in a cell. |
| Apple | Option C | Non-NPN capable UEs will not need to report NPN list. We agree with Samsung here. |
| Nokia | Option A | We agree with Qualcomm that from ANR perspective it is important for the network to collect all available information about neighboring cells. Therefore, it would be desired that all Rel-16 UEs report the available NPN information as well. Reporting about NPN information does not mean that non-NPN capable UEs shall be able to interpret any part of the NPN information.  If reporting about NPN information is not mandatory for all Rel-16 UEs, then the network shall know if the UE is able to report about NPN information; e.g. the gNB should know if a missing NPN information from a neighboring cell is due to configuration change or due to lack of UE reporting capability.  We do not agree with the comments above that the mobility restriction list provided by AMF is the same as UE NPN capability: the lack of CAG subscription does not mean that the UE is not CAG capable, and an AMF in a PLMN does not have any information about SNPN subscriptions. |
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**Summary**:

## 2.4 Issue 16: UE capabilities

**Open issue description:** Views on UE NPN feature support and necessary capabilities.

NPN support in Rel-16 UEs is optional, but there has not been any discussion whether AS level capability indication is needed that the UE supports NPN.

NAS already has a capability for CAG, 24.501/9.11.3.1 (network provides CAG member list via NAS only if the UE supports this capability). The SNPN mode selection is a UE autonomous procedure.

During the email discussion of this issue (see R2-2002659) most of the companies’ view was that no capability indication is needed, one company proposed separate indication for SNPN and PNI-NPN capability and one company commented that CGI reporting for NPN capability indication is needed if it is not a mandatory feature for all Rel-16 UEs.

**Question 4:** Do you agree that AS level capability indication is needed for NPN support? If yes, then please also provide some proposals on the capabilities to be indicated.

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| **Company** | **Answer** | **Comment** |
| Samsung | Disagree |  |
| Huawei | Disagree |  |
| CATT | Disagree |  |
| China Telecom | Disagree |  |
| Vodafone | Disagree | not necessary |
| Intel | Disagree |  |
| Futurewei | Disagree | For SNPN, the AMF acquires UE’s NPN capability by SNPN subscription information.  For PNI-NPN, NAS already has a UE capability indication of CAG, in order for AMF to use the mobility restriction list to inform NG-RAN node the serving NID and allowed CAG list. Hence, NG-RAN node can also acquire UE’s NPN capability information. |
| Ericsson | Disagree | Given that there already is a NAS-level capability for CAG and the support of SNPN can be determined from the selected network, we agree that there is no need for an AS-level capability. |
| Qualcomm | FFS | Depends on outcome of ANR issue |
| Apple | Disagree |  |
| Nokia | Depends on issue 11 | If reporting about NPN information is not mandatory for all Rel-16 UEs, then our view is that the network shall know if the UE is able to report about NPN information or not (see our comment on issue 11). |
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**Summary**:

## 2.5 New Issue: UE behaviour in **licensed** band with non-CAG member cell

**Open issue description:** The UE behaviour in licensed band is FFS when the cell belongs to the correct operator but it’s not a CAG member cell.

During the online discussion of issue 8 of R2-2002659 (“The UE behaviour in unlicensed band is FFS when the cell belongs to the correct operator but it’s not a CAG member cell”, see section 2.1 of this document), it was commented that there is no agreement for licensed band for the same case. Thus, a selection from the following options is also needed for the licensed band scenario:

* **Option A) Follow the NR-U behaviour:**   
  In licensed band when the highest ranked cell or best cell is not suitable due to belonging to the correct operator, but it is not a CAG member cell, the UE shall not consider this cell as candidate for reselection for a maximum of 300 seconds. If the second highest ranked cell on this frequency is not suitable due to belonging to the correct operator, but it is not a CAG member cell, the UE may consider this frequency to be the lowest priority for a maximum of 300 seconds.
* **Option B) Follow the licensed behaviour:**   
  In licensed band when the highest ranked cell or best cell is not suitable due to belonging to the correct operator, but it is not a CAG member cell, the UE shall not consider this cell and other cells on the same frequency, as candidates for reselection for a maximum of 300 seconds.
* **Option C)** Introduce a new flag in SIB1 that indicates whether the UE may (or shall not) consider other cells on the same frequency, as candidates for reselection.

**Question 5: Which option(s) do you prefer?**

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| **Company** | **Preferred** | **Comment** |
| Ericson | Option B (or Option C) | Prefer option B but we can also accept option C. For an example of how option C can work, see our response to Question 1. |
| Qualcomm | Option C | Giving control to the operator with a bit seems like the best option, given we don’t have good enough data to say what the right choice may be. For example, in mmWave, it is quite easy to connect to second-strongest cell without causing interference to the strongest cell, while situation may be different in sub-6. So operator can decide based on their band choices etc. |
| Huawei | Option D: Follow the CSG behaviour | As expressed in Question 1, for licensed, we see no strong motivation to deviate from the LTE CSG behaviour, i.e. if the best cell is not suitable due to not being a CAG member, other cells should not be excluded.  (In LTE CSG, there is:  *If the highest ranked cell or best cell according to absolute priority reselection rules is a CSG cell which is not suitable due to not being a CSG member cell, the UE shall not consider this cell as candidate for cell reselection but shall continue considering other cells on the same frequency for cell reselection.*)  We think Option C (introducing another IFRI bit) is too complicated.  In NPN, we have already introduced a new *cellReservedForOtherUse* IE (named as *cellReservedForFutureUse*), and introducing a new IFRI will make the spec even less readable.  I assume the only possible drawback of legacy CSG behaviour is that UE is likely to select a non-strongest cell on a frequency, suffering from intra-frequency interference.  As Qualcomm pointed out, the interference problem is trivial for FR2. If companies still have some concern on the interference issue, it’s also OK for us to accept Option A (i.e. follow the NR-U behaviour). With Option A, UE will only choose the strongest or the second strongest cell on a frequency, so the interference should be acceptable. |
| CATT | Option A | Option A is preferred with the same reason as for Question 1  1) Considering other cells on the same frequency will improve the success rate of cell reselection.  2) Camping on the second highest ranked cell should have less inter-cell interference than camping on the original serving cell as cell reselection is to find a better cell than serving cell. Therefore inter-cell interference should not be a big concern here. |
| Intel | Option B | For licensed operation, we think we should keep to the best cell concept for UE camping. The up to 300s for treating the other cells in the same frequency not consider candidate for cell reselection provides sufficient flexibility for the UE from cell searching and UE power saving point of view.  As mentioned in our response to 2.1, it also applies here for licensed operation and we do not think Option C should be used |
| Nokia | Option B | Our view is that selecting the non-best cell in licensed band is not desired as it may cause high level of interference. Licensed NR operation is not designed for the case when different networks share a frequency band in an area. CAG cells are different from CSG cells, as their deployment is still expected to be controlled by the PLMN operator.  Note that it is up-to UE implementation how long the frequency is not used for re-selection (only the maximum is specified), therefore a UE implementation in certain cases (e.g. in case of mmWave) may not excluded other cells from re-selection.  Option C has the problem that it does not help when non-CAG cells are deployed in an area (it cannot be assumed that all non-CAG gNBs will support this optional enhancement). |
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**Summary:**

# 3 Conclusions

## 3.1 The following proposals are proposed to be agreed without further discussion:

## 3.2 The following issues are proposed to be discussed further