3GPP TSG-RAN WG2 #103bis Tdoc R2-18xxxxx

Chengdu, China, 2018-10-08 to 2018-10-12

Agenda Item: 10.x.x.x

Source: Ericsson

Title: Email discussion 103bis#23: Relation of feature sets and band combinations

Document for: Discussion, Decision

# 1 Introduction

At RAN2-103bis the Relation of feature sets and band combinations was discussed based on [1]. Companies seemed to agree that the current procedural text in 36.331 and 38.331 does not reveal how the network requests the three capability containers (all in one enquiry or separately), how the network includes the capability filters and how the UE includes the *featureSets* for EUTRA. Depending on how these open issues are resolved, ambiguities among the feature sets provided in and referred to from capability containers may occur.

This email discussion is meant to clarify the problem scope and to identify an agreeable solution direction. If possible, agreeable CRs are supposed to be provided to the next meeting.

# 2 Discussion

## 2.1 Problem Analysis

### 2.1.1 Relation of *featureSet* ID:s

The *UE-MRDC-Capabilities* contain the *supportedBandCombinationList* as well as a list of *featureGroupCombinations*. The latter contains the IDs of EUTRA- and NR Feature Sets. The EUTRA feature sets are conveyed in the *UE-EUTRA-Capabilities* in the field *featureSetsEUTRA-r15*. The NR feature sets are carried in the *UE-NR-Capabilities* in the field *featureSets*. The reasoning behind that split is that the network node needs to know and comprehend only the feature set of its own RAT and in addition the compatible feature set ID for the other RAT.

1. The IDs in UE-MRDC-Capabilities->featureGroupCombinations refer to the *featureSets* in UE-EUTRA-Capabilities and UE-NR-Capabilities

The feature sets do not contain their ID explicitly. It is derived from the position of the feature set in the *featureSets* list. The ID space for feature sets is limited to 1024 elements.

1. The feature sets do not contain their ID explicitly. It is derived from the position of the feature set in the *featureSets* list.

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| Company | Comment |
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### 2.1.2 When to include *featureSetsEUTRA-r15*

The current 36.331 does not indicate explicitly when the UE is supposed to include the *featureSets*EUTRA-r15. The fact that the field is on the top level of the UE-EUTRA-Capabilities may hint that a UE supporting ENDC shall always include this field when the NW enquires capabilities for *eutra*.

There is currently also no procedural text indicating how the UE shall fill the *featureSets*EUTRA-r15. This may hint that the UE shall always include all *featureSets* that it may refer to in any of its supported MRDC band combinations. In other words, the filtered requests (requestedFrequencyBands-r11, requestedMaxCCsDL-r13, ...) do not seem to limit the requested *featureSets*EUTRA-r15.

1. Absence of explicit procedural text seems to imply that the UE includes the full *featureSetsEUTRA-r15* upon UE capability enquiry for RAT type *eutra*.

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| Company | Comment |
| Ericsson | As discussed in the remainder of the document, it may be desirable to avoid including always the complete featureSetsEUTRA-r15.  No matter which way RAN2 chooses, there is certainly a need to specify explicitly what the UE is meant to do. Currently, the procedure is at least ambiguous. |

### 2.1.3 Combined or separate capability enquiry

Currently, 36.331 and 38.331 allow the eNB to request the three capability containers (EUTRA, MRDC, NR) in the same or in subsequent capability enquiry attempts. Being able to request them separately is desirable as it allows the total size to grow beyond 9 Kbyte.

1. The eNB may request the three capability containers (EUTRA, MRDC, NR) in the same or in subsequent capability enquiry attempts.
2. Requesting the containers separately allows the total size to grow beyond 8188 byte and 9000 byte in LTE and NR respectively.

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| Company | Comment |
| Ericsson | Already today, LTE UEs reach the 8188 byte limit with their UE-EUTRA-Capabilities. We consider it therefore important that the NW is able to request MRDC- and NR capabilities separately. |

### 2.1.3 When to include *featureSets* in UE-NR-Capabilities

In the subsequent analysis we assume that the NW requests NR- and MRDC capabilities in subsequent requests. According to 36.331 and 38.331 the UE includes the NR *featureSets* when the NW enquires capabilities for “*nr*”:

36.331, section 5.6.3.3

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| 2> if the *ue-CapabilityRequest* includes *nr* and if the UE supports NR:  3> include the UE radio access capabilities for NR within a *ue-CapabilityRAT-Container*, with the *rat-Type* set to *nr* and in accordance with *requestedFreqBandsNR-MRDC* and as specified in TS 38.331 [82], clause 5.6.1. |

38.331, section 5.6.4

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| 1> if the requested *rat-Type* is *nr*:  2> **include the *featureSets* for the *supportedBandCombinations* included above**;  2> include the *featureSetCombinations* corresponding to the *supportedBandCombinations* and for the *featureSets* included above;  1> if the requested *rat-Type* is *eutra-nr*:  2> include the *featureSetCombinations* corresponding to the *supportedBandCombinations* included above and to the *featureSets* included in a corresponding capability request for *rat-Type* set to *nr*. |

Based on the excerpts from 36.331 and 38.331, the UE is required to return the *UE-NR-Capabilities* with the *supportedBandCombinationList* filtered in accordance with the *FreqBandList* provided by the NW (if any). It also includes the *featureSets* for the *supportedBandCombinationList* as well as the featureSetCombinations.

If the NW requests capabilities for “*nr*” only, it seems natural that the *FreqBandList* should also contain only NR band numbers. Even if the NW would also include LTE band numbers, only the *featureSets* for the NR-only band combinations are included by the text above (since “for the *supportedBandcombinations* included above” refers to the NR band combinations).

Subsequently, the NW may (or may not) perform another capability enquiry for “*eutra-nr*” and request band combinations for the required EUTRA- and NR band numbers. The UE will generate a *supportedBandCombinationList* as described in 38.331, 5.6.1.4 and the corresponding *featureSetCombinations*. The feature set IDs in the latter should refer to feature sets defined previously in the *featureSets* list in the *UE-NR-Capabilities*. However, when generating that one the UE did not know which MRDC band combinations it will later be required to include and hence it is likely that the previously defined *featureSets* do not suffice for the MR-DC band combinations.

1. Even if the NW requests NR- and EUTRA capabilities in one enquiry, the current procedural text suggests that the UE fills the *featureSets* in the UE-NR-Capability container only based on the NR-only band combinations. In particular the procedures for filtered requests don’t cover the EN-DC case correctly.

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| Company | Comment |
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### 2.1.4 Capability enquiries with different filters

A general consequence of the split between band combinations and feature sets and the rule to include only the *featureSets* needed for the currently requested band combinations is that the NW cannot simply merge the band combinations acquired with different filters into a single list of supportedBandCombination. As discussed in the past, this would have been possible in LTE and it would have allowed to collect more band combinations that fit into the maximum PDU size (8188 byte in LTE).

1. Feature sets obtained from subsequent capability enquiries using different filters (e.g. different bands; NR-only vs. MRDC) are not compatible with each other, i.e., the *featureSetId*:s in two *featureSets* lists are likely not consistent.
2. A consequence of Observation 7 is that the NW cannot merge subsequently received *supportedBandCombinationLists* or *featureSets* lists into one (as it would have been possible in LTE).

This constraint means that all nodes in a NW have to enquire capabilities for all bands and number of carriers that are used anywhere in the current PLMN. If e.g. pico cells would request different capabilities than surrounding macro cells, the capabilities stored in the CN would often not match what the current serving cell needs. This would result in frequent capability enquiry procedures over Uu and hence in large connection establishment delays.

1. To avoid significant connection establishment delays due to re-requesting capabilities from UEs frequently, all eNBs and gNBs should request capabilities for all bands that are used anywhere in the PLMN (not only for their own).

This certainly increases the burden on OAM configuration and it may also increase the size of the capabilities requested at once.

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| Company | Comment |
| Ericsson | It should be possible to store capabilities efficiently in the CN and RAN2 should avoid solutions that require the NW to re-request the capabilities from the UEs frequently. |

## 2.2 Solution Directions

The following sub-sections depict possible solution directions how to address this issues outlined in the previous section.

### 2.2.1 Complete Feature Sets

One could change the procedures so that the UE must always include all *featureSets* and that the *featureSets* must not be modified across subsequent requests. While not written specifically, this seems to be what the current procedural text implies for the *featureSets*EUTRA-r15 (see Observation 3).

It is difficult to predict how much the overall size of the *UE-NR-Capability* and *UE-EUTRA-Capabilities* would be impacted by this solution direction. And it might lead to that the total number of *featureSets* (1024) becomes a limiting factor either in terms of RRC message size or in terms of distinguishable feature sets.

1. Requiring the UE to include all un-filtered feature sets in UE-NR- and UE-EUTRA-Capabilities may increase the total size of the transferred UE capabilities and may lead to shortage of feature sets.
2. Alternative 1: Require the UE to include all feature sets in the *featureSets* lists of the *UE-NR-Capabilities* and *UE-EUTRA-Capabilities*, i.e., even the ones that it does not refer to in the currently requested filtered subset of supported band combinations.

If Proposal 1 is adopted, the network could enquire EUTRA-, NR- and MRDC capabilities in any order and with any *FreqBandList* filter and be confident that the *featureSetId*:s used in the *FeatureSetCombinations* unambiguously identify the correct feature sets in the *UE-NR-* and *UE-EUTRA-Capabilities*.

If Proposal 1 is considered unacceptable to its impact on message size or number of *featureSets*, RAN2 should consider other solution directions in the subsequent sub-sections.

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| Company | Comment |
| Ericsson | Considering the number of parameters in the FeatureSets and FeatureSetsPerCC, we fear that including all possible feature sets (unfiltered) is not the best choice. |

### 2.2.2 Consistency within one UECapabilityEnquiry

[1] suggested considering an alternative in which the NW has to request *eutra*, *nr* and/or *eutra-nr* capabilities in a single UECapabilityEnquiry. In this way, the UE could ensure that the *featureSets* in the *UE-EUTRA-Capabilities* and in the *UE-NR-Capabilities* contain all feature set IDs that the *featureSetCombinations* in the *UE-NR-Capabilities* and in the *UE-MRDC-Capabilities* refer to.

1. When the NW requests *eutra*, *nr* and/or *eutra-nr* capabilities in one UECapabilityEnquiry, the UE can ensure that the *featureSets* in the UE-EUTRA-Capabilities and in the UE-NR-Capabilities contain all feature set IDs that the featureSetCombinations in the UE-NR-Capabilities and in the UE-MRDC-Capabilities refer to.

If the network issues subsequent UECapabilityEnquiries with different filters, consistency would not be ensured. Hence, the NW cannot merge and store results from subsequent requests with different filters.

1. Alternative 2: The NW requests *eutra*, *nr* and/or *eutra-nr* capabilities in one UECapabilityEnquiry and the UE ensures that the *featureSets* in the *UE-EUTRA-Capabilities* and in the *UE-NR-Capabilities* contain all feature set IDs that the *featureSetCombinations* in the *UE-NR-Capabilities* and in the *UE-MRDC-Capabilities* refer to.
2. Alternative 2: If RAN2 agrees Proposal 2, the NW stores only UE capabilities enquired with the same filter setting. When storing UE capabilities for another filter setting in the CN (AMF or MME), these replace the previously stored capabilities.

As mentioned in the problem analysis, the current procedures in section 5.6.1 require the UE to “*include the featureSets for the supportedBandCombinations included above*” when the NW requests “*nr*”. The text should be extended so that the UE includes also the *featureSets* for a corresponding request for EN-DC if that was received in the same UE-CapabilityEnquiry.

1. Alternative 2: If RAN2 agrees Proposal 2, extend the procedural text in section 5.6.1.4 so that the UE includes also the *featureSets* for a corresponding request for EN-DC received in the same *UE-CapabilityEnquiry* (if any).

With this approach, there is actually no need to requests *eutra*, *nr* and *eutra-nr* explicitly: If the eNB is not interested in the capabilities for NR SA, it could enquire for rat-Type “eutra-nr” only. The UE would in response include the UE-MRDC-Capabilities and the UE-NR-Capabilities. It could however omit the *supportedBandCombinations* list in the UE-NR-Capabilities and it could omit the *featureSets* needed only for NR-only band combinations.

If the NW is interested in NR and EN-DC capabilities, it should requests “nr” and “eutra-nr” in the same enquiry. In this case, the UE should include also the NR *supportedBandCombinations* and the full *featureSets*.

As can be seen, the *eutra-nr-only* flag is not needed and since its behaviour is currently anyway not described in procedural text, the field could be dummified.

1. Alternative 2: If RAN2 agrees Proposal 2, remove the *eutra-nr-only* flag from the UECapabilityEnquiry in EUTRA and change the procedure so that the UE includes both the *UE-NR-Capabilities* and the corresponding *UE-MRDC-Capabilities* when the NW requests “*eutra-nr*”. If the network does not request “*nr*”, too, the UE omits the *supportedBandCombinations* list and the *featureSets* required only for NR SA in the *UE-NR-Capabilities*.

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| Company | Comment |
| Ericsson | Alternative 2 would require that all three capability containers fit into 8188 byte. We would prefer avoiding this restriction. |

### 2.2.3 Consistency among requests with same filter

When the eNB requests UE capabilities from the UE, each UECapabilityEnquiry may include only one *requestedFreqBandsNR-MRDC-r15*, i.e., only one filter. When requesting NR- and EN-DC band combinations, the NW would be expected to include NR- and EUTRA band numbers in that filter.

If the network is also allowed to include both types of band numbers when requesting only the NR capabilities, RAN2 could modify the procedural text in 38.331, 5.6.1.4 so that the UE includes the NR *featureSets* for EN-DC band combinations that it would include in *supportedBandCombinationsList* if the request would be for *eutra-nr*.

If RAN2 chooses this solution direction, the EN-DC procedures should also be changed so that the UE applies the FreqBandList (filter) also to the *featureSets*EUTRA-r12 (which currently seems to be the full list).

1. If the network is allowed to include both EUTRA- and NR- band numbers even when requesting capabilities for only one RAT-type (“nr” or “eutra”), the UE could determine and include the *featureSets* for all possible band combinations for “nr”, “eutra”, and “eutra-nr”.
2. Alternative 3: The network is allowed to include both NR- and EUTRA band numbers even when requesting capabilities for only one RAT-type.   
   The UE includes *featureSets* based on the provided filter (*FreqBandList*) and not based on the included *supportedBandCombinations*.

This would require corresponding changes to the procedural text but anyway only ensure consistency among capability enquiries using the same filter, i.e., the same *requestedFreqBandsNR-MRDC-r15*.

1. Alternative 3 ensures consistency of *featureSets* and feature set IDs among all capability enquiries with the same filter (*FreqBandList*).

As mentioned before, the procedural text for the *eutra-nr-only* flag is currently missing. In this solution direction, it may serve a purpose: If the eNB includes the *eutra-nr-only* flag in a UE capability enquiry for “*nr*” the UE knows that it is not supposed to include NR-only band combinations. Hence, it could also omit *featureSets* which it would only refer to from NR-only band combinations. To achieve this, the NW should include the *eutra-nr-only* flag not only in the capability enquiry for “*nr*” but already when requesting “*eutra*” (if it plans to requests *nr* and *eutra-nr* later).

1. Alternative 3: If the eNB includes the *eutra-nr-only* flag, the UE omits *featureSets* which it would only refer to from NR-only band combinations. The eNB may include in UECapabilityEnquiry:s for “*eutra*” and/or “*nr*”.

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| Company | Comment |
| Ericsson | This may be a viable approach if it is considered feasible to convey all band combinations needed anywhere in the current PLMN at once, i.e., at least in three subsequent capability enquiries for “eutra”, “nr” and “etura-nr”. |

### 2.2.4 UE-MRDC-Capabilities with own featureSets

Instead of requesting *eutra*, *nr* and *eutra-nr* capabilities with consistent sets of filters, RAN2 could consider removing the coupling of the featureSets among the three capability containers.

The *UE-NR-Capabilities* would only contain the *featureSets* for NR-only band combinations.

The *UE-MRDC-BandCombinations* would contain the EUTRA- and NR- features sets needed for MRDC. To avoid that one RAT has to decode the other RAT’s *featureSets*, they could be included as transparent containers. If RAN2 follows this approach, the requests for eutra-nr, nr and eutra would become fairly self-contained and independent from each other.

The *UE-EUTRA-Capabilities* would not need to contain any featureSets unless RAN2 agrees to use the them also for EUTRA standalone operation.

1. Alternative 4: Remove the dependencies between UE-MRDC-Capabilities and UE-NR/EUTRA-Capabilities by including the *featureSets*NR and *featureSets*EUTRA as OCTET STRINGs into the UE-MRDC-Capabilities. The UE only includes featureSets in accordance with the *supportedBandCombinations* in the same UE capability IE.

This approach would probably require the least changes to procedural text as shown below:

38.331, section 5.6.4: Changes for Alternative 4

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| 1> if the requested *rat-Type* is *nr*:  2> include the *featureSets* for the *supportedBandCombinations* included above;  2> include the *featureSetCombinations* corresponding to the *supportedBandCombinations* and for the *featureSets* included above;  1> if the requested *rat-Type* is *eutra-nr*:  2> include the *featureSetsNR* and *featureSetsEUTRA* for the *supportedBandCombinations* included above;  2> include the *featureSetCombinations* corresponding to the *supportedBandCombinations* included above and to the *featureSetsNR and featureSetsEUTRA* ~~included in a corresponding capability request for~~ *~~rat-Type~~* ~~set to~~ *~~nr~~*. |

The new featureSetsNR and featureSetsEUTRA could be added as backwards compatible non-critical extensions. Of course, the change is anyway not fully backwards compatible. But considering that the current procedures are incomplete/erroneous corrections are required anyway.

Like Alternative 2 and 3, also this solution direction suffers from the problem that subsequent capability requests with different filters are not combinable. Hence, the network must request band combinations for all possible bands and band combinations used anywhere in the PLMN to avoid frequent capability enquiry towards the UE.

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| Company | Comment |
| Ericsson | We are also open for this solution direction. It requires a change in signalling but it might ultimately simplify the handling of capabilities as it removes dependencies among capability containers. |

### 2.2.x [MORE?]

## 2.3 Other issues to be resolved

### 2.3.1 Need to store UE capabilities for different filters

As discussed in [1], the alternative 4 would in principle allow requesting and storing several instances of UE-NR- and UE-MRDC-Capabilities with different filters. It should however be discussed whether the additional complexity is justified or whether each NW could request the band combinations needed anywhere in its PLMN.

1. Discuss whether the NW should be able to store and use capabilities for more than one filter.

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| Company | Comment |
| Ericsson | It would be good to avoid the additional complexity that this brings. If required, we should at least avoid impact to the CN. |

### 2.3.2 Relation between UE-MRDC-Capabilities and UE-NR-Capabilities

At RAN2-103bis one company thought that the content of the UE-NR-Capabilities may be different depending on whether the NW requests them only for EN-DC or also for NR-SA. Other companies argued that all parameters that depend on the band combination (standalone or with LTE) were included in the band combinations or in the feature sets. The other parameters are meant to be independent of whether or not NR is used alone or with EUTRA.

1. Discuss the consistency and dependency of UE-MRDC-Capabilities and UE-NR-Capabilities.

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| Company | Comment |
| Ericsson | Except for the featureSets all other parameters in the UE-NR-Capabilities shall **not** dependent on whether or not the NW also requested the UE-MRDC-Capabilities. RAN2 discussed and agreed that all parameters that may be set differently for NR-SA and EN-DC are inside the band combinations and feature sets.  A NW enquiring both *eutra-nr* and *nr* capabilities can anyway handle just once instance of UE-NR-Capabilities which must be applicable for both modes of operation. |

### 2.3.x [MORE?]

# Conclusion

**TO BE REPLACED by the actual outcome and conclusion of this email discussion!**

In the previous sections we made the following observations:

[Observation 1 The IDs in UE-MRDC-Capabilities->featureGroupCombinations refer to the *featureSets* in UE-EUTRA-Capabilities and UE-NR-Capabilities](#_Toc527725265)

[Observation 2 The feature sets do not contain their ID explicitly. It is derived from the position of the feature set in the *featureSets* list.](#_Toc527725266)

[Observation 3 Absence of explicit procedural text seems to imply that the UE includes the full *featureSetsEUTRA-r15* upon UE capability enquiry for RAT type *eutra*.](#_Toc527725267)

[Observation 4 The eNB may request the three capability containers (EUTRA, MRDC, NR) in the same or in subsequent capability enquiry attempts.](#_Toc527725268)

[Observation 5 Requesting the containers separately allows the total size to grow beyond 8188 byte and 9000 byte in LTE and NR respectively.](#_Toc527725269)

[Observation 6 Even if the NW requests NR- and EUTRA capabilities in one enquiry, the current procedural text suggests that the UE fills the *featureSets* in the UE-NR-Capability container only based on the NR-only band combinations. In particular the procedures for filtered requests don’t cover the EN-DC case correctly.](#_Toc527725270)

[Observation 7 Feature sets obtained from subsequent capability enquiries using different filters (e.g. different bands; NR-only vs. MRDC) are not compatible with each other, i.e., the *featureSetId*:s in two *featureSets* lists are likely not consistent.](#_Toc527725271)

[Observation 8 A consequence of Observation 7 is that the NW cannot merge subsequently received *supportedBandCombinationLists* or *featureSets* lists into one (as it would have been possible in LTE).](#_Toc527725272)

[Observation 9 To avoid significant connection establishment delays due to re-requesting capabilities from UEs frequently, all eNBs and gNBs should request capabilities for all bands that are used anywhere in the PLMN (not only for their own).](#_Toc527725273)

[Observation 10 Requiring the UE to include all un-filtered feature sets in UE-NR- and UE-EUTRA-Capabilities may increase the total size of the transferred UE capabilities and may lead to shortage of feature sets.](#_Toc527725274)

[Observation 11 When the NW requests *eutra*, *nr* and/or *eutra-nr* capabilities in one UECapabilityEnquiry, the UE can ensure that the *featureSets* in the UE-EUTRA-Capabilities and in the UE-NR-Capabilities contain all feature set IDs that the featureSetCombinations in the UE-NR-Capabilities and in the UE-MRDC-Capabilities refer to.](#_Toc527725275)

[Observation 12 If the network is allowed to include both EUTRA- and NR- band numbers even when requesting capabilities for only one RAT-type (“nr” or “eutra”), the UE could determine and include the *featureSets* for all possible band combinations for “nr”, “eutra”, and “eutra-nr”.](#_Toc527725276)

[Observation 13 Alternative 3 ensures consistency of *featureSets* and feature set IDs among all capability enquiries with the same filter (*FreqBandList*).](#_Toc527725277)

Based on the discussion in the previous sections we propose the following:

[Proposal 1 Alternative 1: Require the UE to include all feature sets in the *featureSets* lists of the *UE-NR-Capabilities* and *UE-EUTRA-Capabilities*, i.e., even the ones that it does not refer to in the currently requested filtered subset of supported band combinations.](#_Toc527725278)

[Proposal 2 Alternative 2: The NW requests *eutra*, *nr* and/or *eutra-nr* capabilities in one UECapabilityEnquiry and the UE ensures that the *featureSets* in the *UE-EUTRA-Capabilities* and in the *UE-NR-Capabilities* contain all feature set IDs that the *featureSetCombinations* in the *UE-NR-Capabilities* and in the *UE-MRDC-Capabilities* refer to.](#_Toc527725279)

[Proposal 3 Alternative 2: If RAN2 agrees Proposal 2, the NW stores only UE capabilities enquired with the same filter setting. When storing UE capabilities for another filter setting in the CN (AMF or MME), these replace the previously stored capabilities.](#_Toc527725280)

[Proposal 4 Alternative 2: If RAN2 agrees Proposal 2, extend the procedural text in section 5.6.1.4 so that the UE includes also the *featureSets* for a corresponding request for EN-DC received in the same *UE-CapabilityEnquiry* (if any).](#_Toc527725281)

[Proposal 5 Alternative 2: If RAN2 agrees Proposal 2, remove the *eutra-nr-only* flag from the UECapabilityEnquiry in EUTRA and change the procedure so that the UE includes both the *UE-NR-Capabilities* and the corresponding *UE-MRDC-Capabilities* when the NW requests “*eutra-nr*”. If the network does not request “*nr*”, too, the UE omits the *supportedBandCombinations* list and the *featureSets* required only for NR SA in the *UE-NR-Capabilities*.](#_Toc527725282)

[Proposal 6 Alternative 3: The network is allowed to include both NR- and EUTRA band numbers even when requesting capabilities for only one RAT-type. The UE includes *featureSets* based on the provided filter (*FreqBandList*) and not based on the included *supportedBandCombinations*.](#_Toc527725283)

[Proposal 7 Alternative 3: If the eNB includes the *eutra-nr-only* flag, the UE omits *featureSets* which it would only refer to from NR-only band combinations. The eNB may include in UECapabilityEnquiry:s for “*eutra*” and/or “*nr*”.](#_Toc527725284)

[Proposal 8 Alternative 4: Remove the dependencies between UE-MRDC-Capabilities and UE-NR/EUTRA-Capabilities by including the *featureSets*NR and *featureSets*EUTRA as OCTET STRINGs into the UE-MRDC-Capabilities. The UE only includes featureSets in accordance with the *supportedBandCombinations* in the same UE capability IE.](#_Toc527725285)

[Proposal 9 Discuss whether the NW should be able to store and use capabilities for more than one filter.](#_Toc527725286)

[Proposal 10 Discuss the consistency and dependency of UE-MRDC-Capabilities and UE-NR-Capabilities.](#_Toc527725287)

# Annex A – UE Capability Enquiry in 36.331

#### 5.6.3.3 Reception of the *UECapabilityEnquiry* by the UE

The UE shall:

...

2> if the *ue-CapabilityRequest* includes *nr* and if the UE supports NR:

3> include the UE radio access capabilities for NR within a *ue-CapabilityRAT-Container*, with the *rat-Type* set to *nr* and in accordance with *requestedFreqBandsNR-MRDC* and as specified in TS 38.331 [X2, 5.6.1].

2> if the *ue-CapabilityRequest* includes *eutra-nr* and if the UE supports EN-DC:

3> include the UE radio access capabilities for EUTRA-NR within a *ue-CapabilityRAT-Container*, with the *rat-Type* set to *eutra-nr* and in accordance with in accordance with *requestedFreqBandsNR-MRDC* and as specified in TS 38.331 [82, 5.6.1].

1> submit the *UECapabilityInformation* message to lower layers for transmission, upon which the procedure ends;

# Annex B – UE Capability Enquiry in 38.331

### 5.6.1 UE capability transfer

#### 5.6.1.1 General



Figure 5.6.1.1-1: UE capability transfer

#### 5.6.1.2 Initiation

The network initiates the procedure to a UE in RRC\_CONNECTED when it needs (additional) UE radio access capability information.

#### 5.6.1.3 Reception of the *UECapabilityEnquiry* by the UE

The UE shall set the contents of *UECapabilityInformation* message as follows:

1> if the *ue-CapabilityRequest* includes *nr*:

2> include the *UE-NR-Capability* within a *ue-CapabilityRAT-Container* and with the *rat-Type* set to *nr*;

2> include band combinations supported by the UE into *supportedBandCombination* as specified in 5.6.1.4;

1> if the *ue-CapabilityRequest* includes *eutra* and if the UE supports EUTRA:

2> include the *UE-EUTRA-Capability* within a *ue-CapabilityRAT-Container* and with the *rat-Type* set to *eutra*;

1> submit the *UECapabilityInformation* message to lower layers for transmission, upon which the procedure ends.

Editor’s Note: FFS whether NR UECapabilityEnquiry is also used for EN-DC.

#### 5.6.1.4 Compilation of band combinations supported by the UE

The UE shall:

1> if *FreqBandList* is received:

2> if the received *FreqBandList* contains at least one of *maxBandwidthRequestedDL*, *maxBandwidthRequestedUL*, *maxCarriersRequestedDL* or *maxCarriersRequestedUL* for at least one of the bands:

3> compile a list of band combinations, candidate for inclusion in the *UECapabilityInformation* message, only consisting of bands included in *FreqBandList*, where for each band in the band combination, the parameters of the band do not exceed the corresponding parameters provided by the IEs *maxBandwidthRequestedDL, maxBandwidthRequestedUL, maxCarriersRequestedDL, maxCarriersRequested, ca-BandwidthClassDL-EUTRA or ca-BandwidthClassUL-EUTRA,* whichever are recevied.

2> else:

3> compile a list of band combinations, candidate for inclusion in the *UECapabilityInformation* message, only consisting of bands included in *FreqBandList*, and prioritized in the order of *FreqBandList*, (i.e. first include remaining band combinations containing the first-listed band, then include remaining band combinations containing the second-listed band, and so on);

2> for each band combination included in the candidate list:

3> if it is regarded as a fallback band combination with the same capabilities of another band combination included in the list of candidates as specified in TS 38.306 [xx]:

4> remove the band combination from the list of candidates;

2> include all band combinations in the candidate list into *supportedBandCombination*;

2> include the received *FreqBandList* in the field *appliedFreqBandListFilter* of the requested UE capability;

1> else:

2> include all band combinations supported by the UE into *supportedBandCombination,* excluding fallback band combinations with the same capabilities of another band combination included in the list of band combinations supported by the UE;

1> if the requested *rat-Type* is *nr*:

2> include the *featureSets* for the *supportedBandCombinations* included above;

2> include the *featureSetCombinations* corresponding to the *supportedBandCombinations* and for the *featureSets* included above;

1> if the requested *rat-Type* is *eutra-nr*:

2> include the *featureSetCombinations* corresponding to the *supportedBandCombinations* included above and to the *featureSets* included in a corresponding capability request for *rat-Type* set to *nr*.

NOTE: For EN-DC, the network needs the capabilities for RAT types *nr* and *eutra-nr* and it uses the *featureSets* in the *UE-NR-Capabilities* together with the *featureSetCombinations* in the *UE-MRDC-Capabilities* to determine the UE capabilities for the supported MRDC band combinations. Hence, the IDs used in the *featureSets* must match to the IDs referred to in *featureSetCombinations*.

# References

1. [R2-1814979](ftp://ftp.3gpp.org/tsg_ran/WG2_RL2/TSGR2_103bis/Docs//R2-1814979.zip), “Relation of feature sets and band combinations”, Ericsson, RAN2-103bis, Chengdu, China