**3GPP TSG RAN WG1 #100bis-e R1-20xxxxx**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-NRU-01]

Agenda Item: 7.2.11.2

**Document for:** **Discussion and Decision**

# **Introduction**

This contribution summarizes the following email discussion in AI 7.2.11.2 regarding UE features for NR-U.

[100b-e-NR-UEFeatures-NRU-01] Email discussion/approval on the basic feature groups structure for NR-U (20th-24th April) – (DCM, Hiroki)

* Discuss on how to define basic FGs to cover all deployment scenarios
	+ Options 1 and 2 stated below are the starting point
		- Option 1: define new basic FGs in addition to current basic FGs to cover all deployment scenarios (e.g., [3] and [5])
		- Option 2: define new basic FGs with components that have tightly related functionality to replace current basic FGs (e.g., [8])
* Discuss whether/how following FGs can be included in basic FGs
	+ 10-3, 10-11, 10-14, 10-15, 10-16, 10-16a, 10-17, 10-18, 10-19, 10-20, 10-20a, 10-24, 10-25, 10-28, 10-29, 10-30
	+ Whether or not “Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0” can be separate capability from basic FGs
	+ Whether or not “Type 2B channel access” can be separate capability from basic FGs

# **10-1 to 10-2b: Possible basic feature groups for operating in unlicensed band and their related feature group**

In [1], FGs 10-1 to 10-2b are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 10. NR-unlicensed | 10-1 | UE stand-alone (DL and UL) operation in shared spectrum under dynamic channel access mode  | 1. Type 1 channel access2. Type 2A channel access3. Type 2B channel access (FFS if move this to separate feature)4. Type 2C channel access5. 20MHz LBT bandwidth6. Contention window adjustment7. CP extension up to 1 symbol for PUSCH/PUCCH transmission8. SSB/MIB/RMSI reception with Q9. SSB RRM with Q in DMTC10. SSB-RLM with Q in DMTC window11. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0 |  |  | N/A |  | Per band | N/A | N/A |  | This can be a basic feature group for operating in unlicensed band with both DL and UL transmission support under dynamic channel access | Optional with capability signalling |
| 10-1a | UE DL only operation in shared spectrum under dynamic channel access mode | 1. SSB RRM with Q in DMTC | 6-5 |  | N/A |  | Per band | N/A | N/A |  | This can be a basic feature group for operating in unlicensed band with DL only operation | Optional with capability signalling |
| 10-2 | UE stand-alone (DL and UL) operation in shared spectrum under semi-static channel access mode  | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB/MIB/RMSI reception with Q5. SSB RRM with Q in DMTC6. SSB-RLM with Q in DMTC window7. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_08. Support fixed frame period of 5ms and 10ms |  |  | N/A |  | Per band | N/A | N/A |  | This can be a basic feature group for operating in unlicensed band.Support of channel access mechanism for FBE operation, including fixed frame period, Cat 2 LBT, Cat 1 LBT | Optional with capability signalling |
| 10-2a | UE DL only operation in shared spectrum under semi-static channel access mode | 1. SSB RRM with Q in DMTC2. Support fixed frame period of 5ms and 10ms | 6-5 |  | N/A |  | Per band | N/A | N/A |  | This can be a basic feature group for operating in unlicensed band with DL only operation | Optional with capability signalling |
| 10-2b | UE stand-alone (DL and UL) operation in shared spectrum under semi-static channel access mode  | 1. Support fixed frame periods shorter than 5ms | 10-2 or 10-2a |  | N/A |  | Per band | N/A | N/A |  |  | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | ZTE, Sanechips | For NR-U, depending on different use scenarios, there could be multiple basic feature groups defined for UE to support LBE mode (DL+UL), FBE mode (DL+UL), LBE mode (DL only) and FBE mode (DL only), respectively. The different operation modes can be regarded as different sub-features for the NR-U feature.Each basic feature group includes multiple components that are essential for the UE to support the sub-feature. Other optional feature groups can use one or multiple of the above basic feature groups as prerequisite. One thing could be further discussed is that whether or not to include more components to the basic feature group, for example the supported enhancements on HARQ, configured grant, SRS and CORESET/SS. Those enhancements are used to compensate the potential loss of LBT failure in terms of efficiency and reliability, it may be useful to make these function as mandatory, at least for LBE mode.***Proposal 1:*** * ***Multiple basic feature groups can be defined for NR-U, corresponding to different operation modes.***
	+ ***Further discuss whether the enhancements on CORESET/SS, SRS, HARQ, CG can be merged into the basic feature group(s).***
 |
| [3] | vivo | In current table, different basic feature groups (i.e. 10-1, 10-1a, 10-2, 10-2a) are defined to support standalone and CA DL only scenario for LBE and FBE respectively. However, the scenario regarding CA DL+UL operation in unlicensed band is missing. Under this scenario, initial access related features are not needed as components in this basic feature group compared to standalone scenario. Therefore, the following should be added as separate basic feature groups: a) UE DL and UL operation in shared spectrum under dynamic channel access mode; b) UE DL and UL operation in shared spectrum under semi-static channel access mode.Proposal 3: Add the following two basic feature groups to NRU UE feature table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 10-1b | UE DL and UL operation in shared spectrum under dynamic channel access mode  | 1. Type 1 channel access2. Type 2A channel access3. Type 2B channel access (FFS if move this to separate feature)4. Type 2C channel access5. 20MHz LBT bandwidth6. Contention window adjustment7. CP extension up to 1 symbol for PUSCH/PUCCH transmission8. SSB RRM with Q in DMTC | 6-5 |
| 10-2c | UE DL and UL operation in shared spectrum under semi-static channel access mode | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB RRM with Q in DMTC5. Support fixed frame period of 5ms and 10ms | 6-5 |

On **10-2a** (*UE DL only operation in shared spectrum under semi-static channel access mode*), we don’t see much difference with different FFP period for LAA DL only scenario. In LAA DL only case, UE only performed reception in shared spectrum and shorter FFP period doesn’t bring more complexity. Therefore, the component “Support fixed frame period of 5ms and 10ms” is not needed.Proposal 4: Remove component “Support fixed frame period of 5ms and 10ms” from 10-2a. |
| [4] | OPPO | **FG 10-1, 10-1a, 10-2, 10-2a**: SSB RRM with Q in DMTC, in NRU we should replace DMTC with SMTC. Moreover, SSB RLM with Q in DMTC, in NRU we should replace DMTC with discovery burst transmission window. Another point is that Type 2B channel access should not be a basic component. NRU can perfectly runs its function without having to implement Type 2B channel access.

|  |  |  |
| --- | --- | --- |
| 10-1 | UE stand-alone (DL and UL) operation in shared spectrum under dynamic channel access mode  | 1. Type 1 channel access2. Type 2A channel access3. ~~Type 2B channel access (FFS if move this to separate feature)~~4. Type 2C channel access5. 20MHz LBT bandwidth6. Contention window adjustment7. CP extension up to 1 symbol for PUSCH/PUCCH transmission8. SSB/MIB/RMSI reception with Q9. SSB RRM with Q in ~~DMTC~~ SMTC10. SSB-RLM with Q in ~~DMTC~~ discovery burst transmission window11. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0 |
| 10-1a | UE DL only operation in shared spectrum under dynamic channel access mode | 1. SSB RRM with Q in ~~DMTC~~ SMTC |
| 10-2 | UE stand-alone (DL and UL) operation in shared spectrum under semi-static channel access mode  | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB/MIB/RMSI reception with Q5. SSB RRM with Q in ~~DMTC~~ SMTC6. SSB-RLM with Q in ~~DMTC~~ discovery burst transmission window7. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_08. Support fixed frame period of 5ms and 10ms |
| 10-2a | UE DL only operation in shared spectrum under semi-static channel access mode | 1. SSB RRM with Q in ~~DMTC~~ SMTC2. Support fixed frame period of 5ms and 10ms |

**Proposal 1: Remove Type 2B channel access from basic feature group 10-1.**  |
| [5] | MediaTek Inc. | According to NR-U WID, Rel-16 NR-U aims to support the following deployment scenarios. However, with the current UE feature structure, it may not be feasible for UE to indicate its support for the deployments highlighted in yellow without excessive support of NR-U features. Scenario A specifies the carrier aggregation where NR-U serves as a secondary cell (SCell). In this scenario, UE should not be mandated to support procedures such as MIB/RMSI acquisition, RACH, and RLM in an unlicensed cell. In Scenario D where NR-R stand-alone operation is targeted but only DL is in unlicensed and UL is in licensed band. In this case, UE should support initial access procedures but does not have to support uplink features such as channel access procedures or interlaced resource mapping. Therefore, the corresponding basic feature groups should be defined for it. Alternatively, we can discuss whether this scenario should be supported. * Scenario A: Carrier aggregation between licensed band NR (PCell) and NR-U (SCell).
	+ NR-U SCell may have both DL and UL, or DL-only.
	+ In this scenario, NR PCell is connected to 5G-CN.
* Scenario B: Dual connectivity between licensed band LTE (PCell) and NR-U (PSCell)
	+ In this scenario, LTE PCell connected to EPC as higher priority than PCell connected to 5G-CN.
* Scenario C: Stand-alone NR-U
	+ In this scenario, NR-U is connected to 5G-CN.
* Scenario D: A stand-alone NR cell in unlicensed band and UL in licensed band (single cell architecture).
	+ In this scenario, NR-U is connected to 5G-CN.
* Scenario E: Dual connectivity between licensed band NR and NR-U.
	+ In this scenario, PCell is connected to 5G-CN.

**Proposal 2: The NR-U UE feature list should make it possible that UE can indicate which NR-U deployment scenarios it is capable of supporting without excessive support of other NR-U features.** **Proposal 3: UE should not be mandated to support MIB/RMSI acquisition, RACH, and RLM when it only plans to support Scenario A specified in NR-U WID.** **Proposal 4: Add basic feature groups (10-1c and 10-2d added to the table below) for carrier aggregation between NR licensed (PCell) and NR-U (SCell) where the NR-U SCell have both DL and UL.** **Proposal 5: Add basic feature groups (10-1b and 10-2c added to the table below) for Scenario D or discuss whether Scenario D should be supported.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 10-1b | UE stand-alone (DL only) operation in shared spectrum under dynamic channel access mode | 1. SSB/MIB/RMSI reception with *SSB-PositionQCL-Relationship*2. SSB RRM with *SSB-PositionQCL-Relationship* in DMTC3. SSB-RLM with *SSB-PositionQCL-Relationship* in DMTC window4. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_05. Support monitoring DCI 2\_0 to read availableRB-Sets-r166. Support monitoring DCI 2\_0 to read CO duration |  |  | N/A |  | Per band | N/A | N/A |  | This can be a basic feature group for the Scenario D in NR-U WID | Optional with capability signalling  |
| 10-1c | UE DL and UL operation in shared spectrum under dynamic channel access mode | 1. Type 1 channel access2. Type 2A channel access3. Type 2B channel access (FFS if move this to separate feature)4. Type 2C channel access5. 20MHz LBT bandwidth6. Contention window adjustment7. CP extension up to 1 symbol for PUSCH/PUCCH transmission8. SSB RRM with *SSB-PositionQCL-Relationship* in DMTC9. Support monitoring DCI 2\_0 to read availableRB-Sets-r1610. Support monitoring DCI 2\_0 to read CO duration | 6-5 and 6-6 |  | N/A |  | Per band | N/A | N/A |  | This can be a basic feature group for operating in an unlicensed SCell with both DL and UL | Optional with capability signalling |
| 10-2c | UE stand-alone (DL only) operation in shared spectrum under semi-static channel access mode | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB/MIB/RMSI reception with Q5. SSB RRM with Q in DMTC6. SSB-RLM with Q in DMTC window7. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_08. FFS: Support fixed frame period of 5ms and 10ms9. Support monitoring DCI 2\_0 to read availableRB-Sets-r1610. Support monitoring DCI 2\_0 to read CO duration11. Invalidate RACH occasions that partially or fully fall within the idle period of a fixed frame period  |  |  |  |  |  |  |  |  | This can be a basic feature group for the Scenario D in NR-U WID | Optional with capability signalling  |
| 10-2d | UE DL and UL operation in shared spectrum under semi-static channel access mode | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB RRM with Q =8 in DMTC5. UL transmission conditioned on the detection of DL transmission in the same fixed frame period6. FFS: Support fixed frame period of 5ms and 10ms | 6-5 and 6-6 |  |  |  |  |  |  |  | This can be a basic feature group for operating in an unlicensed SCell with both DL and UL | Optional with capability signalling  |

With the introduction of discovery burst transmission windows, the number of SSB positions that UE has to monitor for measurements and PBCH reading is increased dramatically especially for small Q values. In addition, PCI collision is no new issue in NR-U. LTE-LAA has the same issue. However, it is resolved by eNB without mandating UE to read and report CGI. **Proposal 6: For a UE that only supports NR-U as SCell (i.e. CA deployments in unlicensed operation), the UE is not required to read PBCH of an unlicensed cell.** HARQ procedures are essential for stand-alone operation. However, they are missing from the basic feature groups for stand-alone. **Proposal 10: Add the following HARQ components to the basic feature groups for stand-alone operation 10-1 and 10-2.** * **Non-numerical PDSCH to HARQ-ACK timing**
* **Enhanced dynamic HARQ-ACK codebook**

For FBE feature group 10-2b, it is not clear why FFP smaller than 5ms needs to be single out. So far we only have an agreement saying no SSB and corresponding PDSCH rate matching is required when an SSB falls within an idle period. But this does not evoke us that much difference between handling an FFP smaller than 5ms and handling an FFP not smaller than 5ms. **Proposal 11: Discuss whether we need 10-2b.** |
| [7] | Intel Corporation | It is proposed to clarify that the basic feature groups including 10-1, 10-1a, 10-2, and 10-2a are targeting unlicensed band in the FR1 regime in order to avoid unnecessary capability signaling to licensed band or FR2. Therefore, it is proposed to put the restriction of FR1 unlicensed band in the note of the basic feature groups as shown below:**Proposal 1: Put the restriction of FR1 unlicensed band in the note of 10-1, 10-1a, 10-2, and 10-2a.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Type** | **Note** | **Mandatory/Optional** |
| 10-1 | UE stand-alone (DL and UL) operation in shared spectrum under dynamic channel access mode  | 1. Type 1 channel access2. Type 2A channel access3. Type 2B channel access (FFS if move this to separate feature)4. Type 2C channel access5. 20MHz LBT bandwidth6. Contention window adjustment7. CP extension up to 1 symbol for PUSCH/PUCCH transmission8. SSB/MIB/RMSI reception with Q9. SSB RRM with Q in DMTC10. SSB-RLM with Q in DMTC window11. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0 |  | Per band | This can be a basic feature group for operating only in FR1 unlicensed band with both DL and UL transmission support under dynamic channel access | Optional with capability signalling |
| 10-1a | UE DL only operation in shared spectrum under dynamic channel access mode | 1. SSB RRM with Q in DMTC | 6-5 | Per band | This can be a basic feature group for operating only in FR1 unlicensed band with DL only operation | Optional with capability signalling |
| 10-2 | UE stand-alone (DL and UL) operation in shared spectrum under semi-static channel access mode  | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB/MIB/RMSI reception with Q5. SSB RRM with Q in DMTC6. SSB-RLM with Q in DMTC window7. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_08. Support fixed frame period of 5ms and 10ms |  | Per band | This can be a basic feature group for operating only in FR1 unlicensed band with DL only operation | Optional with capability signalling |
| 10-2a | UE DL only operation in shared spectrum under semi-static channel access mode | 1. SSB RRM with Q in DMTC2. Support fixed frame period of 5ms and 10ms | 6-5 | Per band | This can be a basic feature group for operating only in FR1 unlicensed band with DL only operation | Optional with capability signalling |

It is OK to have 10-2 and 10-2a for both stand-alone operation and DL only operation. However, current table has different feature groups for stand-alone operation depending on the fixed frame period length. We do not have clear motivation to define additional feature groups for supporting small fixed frame period length. And this differentiation is only applied for stand-alone operation and not applied for DL only operation, which does not look desirable either.**Proposal 2: Remove 10-2b and change the 8th bullet of 10-2.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | **Type** | Note | Mandatory/Optional |
| 10-2 | UE stand-alone (DL and UL) operation in shared spectrum under semi-static channel access mode  | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB/MIB/RMSI reception with Q5. SSB RRM with Q in DMTC6. SSB-RLM with Q in DMTC window7. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0 |  | Per band | This can be a basic feature group for operating in unlicensed band.Support of channel access mechanism for FBE operation, including fixed frame period, Cat 2 LBT, Cat 1 LBT | Optional with capability signalling |
| 10-2a | UE DL only operation in shared spectrum under semi-static channel access mode | 1. SSB RRM with Q in DMTC2. Support fixed frame period of 5ms and 10ms | 6-5 | Per band | This can be a basic feature group for operating in unlicensed band with DL only operation | Optional with capability signalling |
|  |  |  |  |  |  |  |

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| [8] | Ericsson | We observe that in the most recent UE features list [R1-2001484] there has been an attempt to define feature groups based on some (but not all) deployment scenarios for both LBE and FBE with some components repeated in multiple feature groups. We refer to this as “deployment based grouping.” For example, 10-1 is currently defined for standalone (Scenario C) for LBE, and 10-1a is for DL only LAA operation (one of the 2 possible deployments in Scenario A). There are several problems with deployment based grouping, namely:* It is not consistent with the grouping approach used in Rel-15. As NR evolves, a consistent approach should be used across releases.
	+ In Rel-15, the Notes column in TR38.822 was used to provide information on which deployment scenarios a particular feature group is applicable to when needed, and this same approach can be used in Rel-16 if needed.
* Not all deployment scenarios are covered, e.g., dual connectivity is missing
	+ It becomes unmanageable to define basic feature groups for all possible deployment scenarios
	+ The structure will unnecessarily restrict the ability to signal support for a different deployment scenario in the future that may need a different combination of components
* The basic feature groups have overlapping functionality
	+ This can complicate IODT testing in that there would likely need to be a partitioning of components different from the defined feature groups which is undesirable
* It becomes very hard to define prerequisites in a logical way
	+ If basic FGs are defined only for a subset of scenarios (as in [R1-2001484] currently), what pre-requisite should be defined for a FG-x if the UE implementation is targeted for a deployment for which a basic FG is not defined?
	+ IODT testing becomes complicated if multiple pre-requisites corresponding to different deployments are needed to capture the pre-requisite components

To alleviate these problems, it is better to define basic feature groups with components that have tightly related functionality. The goal of this grouping is that for any given deployment scenario, the pre-requisites can be defined as a subset of the basic feature groups, and those feature groups by design should have non-overlapping functionality. This is the approach that was used in Rel-15 and is closer to the approach that was used in the prior version of the UE feature list [R1-2000390] in contrast to the deployment-based grouping approach in the current version [R1-2001484]. The Notes column in TR 38.822 can be used to indicate which functionality is necessary for a particular deployment scenario if needed.Based on this we make the following proposals that should be used as general principles:1. Define basic feature groups with components that have tightly related functionality
2. Define basic feature groups that have non-overlapping functionality as much as possible

Based on these general principles, we propose to replace the 5 basic FGs 10-1, 10-1a, 10-2, 10-2a, and 10-2c in [R1-2001484] by the following 5 basic feature groups. We note that FGs 10-2, 10-3, and 10-4 in this proposal very much follow the structure used in Rel-15 for FGs 1-1 and 1-3 related to initial access, RRM, RLM, and RMSI reception (see Appendix of [R1-2001484]).1. Replace FGs 10-1, 10-1a, 10-2, 10-2a, and 10-2c in by the 5 basic feature groups shown in the table below

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 10. NR-unlicensed | 10-1 | UL channel access for dynamic channel access mode  | 1. Type 1 channel access2. Type 2A channel access3. Type 2B channel access (FFS whether or not this should be defined as a separate FG)4. Type 2C channel access5. 20MHz LBT bandwidth6. Contention window adjustment7. CP extension up to 1 symbol for PUSCH/PUCCH transmission |  |  | N/A |  | Per band | N/A | N/A |  | Basic feature group | Optional with capability signaling |
| 10-1a | UL channel access for semi-static channel access mode | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth |  |  | N/A |  | Per band | N/A | N/A |  | Basic feature group | Optional with capability signaling |
| 10-2 | SSB reception (including reading MIB) and SSB-based RRM | 1. SSB reception with Q2. SSB RRM with Q |  |  | N/A |  | Per band | N/A | N/A |  | Basic feature group | Optional with capability signaling |
| 10-3 | SSB-based RLM | 1. SSB RLM with Q |  |  | N/A |  | Per band | N/A | N/A |  | Basic feature group | Optional with capability signaling |
| 10-4 | SIB1 reception | 1. SIB1 reception with Q |  |  | N/A |  | Per band | N/A | N/A |  | Basic feature groupNote: SIB1 reception for ANR (FG 10-23) remains as a separate FG with 10-4 as a pre-requisite | Optional with capability signaling |

With the basic feature groups defined as above, all of the deployment scenarios captured in the WID are covered with combinations of the basic feature groups. The deployment scenarios can be summarized as follows:1. SCell (DL only) in unlicensed band
	1. Maps to Scenario A with DL only, i.e., LAA – DL Only
	2. Required Basic FGs: 10-2
2. SCell (DL + UL) in unlicensed band
	1. Maps to Scenario A with DL + UL, i.e., LAA – DL + UL
	2. Required Basic FGs:
		1. LBE: 10-1 + 10-2
		2. FBE: 10-1a + 10-2
3. PSCell in unlicensed band
	1. Maps to Scenario B and E, i.e., ENDC and NR-NR DC
	2. Required Basic FGs: 10-1 + 10-2 + 10-3
4. PCell in unlicensed band
	1. Maps to Scenario C and D, i.e., Standalone and Standalone + SUL
	2. Required Basic FGs:
		1. LBE: 10-1 + 10-2 + 10-3 + 10-4
		2. FBE: 10-1a + 10-2 + 10-3 + 10-4

In this way, the deployment scenarios are described based on different combinations of the basic feature groups. Moreover, the basic feature groups have non-overlapping functionality as much as possible, thus simplifying IODT testing.As a general principle, feature group A should be listed as a pre-requisite for feature group B only if feature group B cannot *functionally* operate without feature group A.For operation in shared spectrum, a UE should indeed support UL LBT. However, the **functionality** of feature groups, for example one-shot-HARQ (10-16), that have nothing to do with UL LBT operation should not have the feature group with UL LBT as a prerequisite. This means that it is technically incorrect to include 10-1 or 10-2 as a pre-requisite for 10-16 (numbering as per the latest draft in [R1-2001484]). It should be noted that feature group 10-16 being listed as part of feature “10. NR-unlicensed” in TR 38.822 makes it amply clear that this feature was developed for operation in unlicensed spectrum. There is no further need to artificially link functionally unrelated feature groups together to attempt to indicate the intended scenario for a feature. This type of pre-requisite definition has the same issues as the deployment based grouping discussed in the previous section.We have previously commented that adding pre-requisite features for a feature group should have technical justifications with respect to the functionality being tested for the feature group. Hence, we reiterate the following proposal.1. We propose the following:
* A feature group A should be listed as a pre-requisite for another feature group, B, only if feature group B cannot functionally operate without feature group A.
* The basic feature groups related to UL channel access should be removed as pre-requisites from the following feature groups (as per the latest draft in [R1-2001484]) since these feature groups do not require UL LBT to operate:
	+ 10-3, -3a, -3b, -3c, -9, -9a, -9b, -9c, -10, -11, -14, -15, -16, -16a, -17, -18a, -19a, -19c, -20, -20a, -23, -24, -26, -27, -28, -29, -30, -31

For supporting the semi-static channel access mode, the main additional functionalities that are useful to be implemented in the UE are1. RACH validation to take into account idle periods in the fixed frame period
2. Sensing in a single slot of 9 us

It should be noted that the system can operate in FBE even without these two functionalities with appropriate configuration of RACH occasions and with the use of a short LBT over 25 μs that also meets the requirements of sensing in a single slot of 9 μs. Therefore, there is no necessity to define multiple feature groups individually for dynamic and semi-static channel access modes. Only a basic feature group for dynamic channel access and one for semi-static channel access as in Proposal 3 are needed. Furthermore, for semi-static channel access mode, support of fixed frame period of 5 and 10 ms is listed. It is not clear why a limitation to a fixed frame period of 5 and 10 ms needs to be included in the feature group definition considering the functionalities listed above for which there isn’t any significant complexity difference between for the different fixed frame periods. Finally, the current structure doesn’t allow signaling of support for fixed frame periods that are less than 5 and 10 ms unless the UE also supports UL which seems like a very strange restriction.1. Remove values for fixed frame period from the definition of feature groups related to semi-static channel access

Component 11 is “Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0” in our view, it is not critical if NR-U capable UEs do not support the extended RAR window. Collisions do not happen frequently, and if there is a collision, a UE can retry to access the channel again. It is true that the gNB does not know the UE’s capability if the RACH procedure is initiated by the IDLE/INACTIVE UE. However, if support of extended RAR is a separate FG with its own an capability bit, this can be used to collect statistics on UE capabilities, and the gNB may decide based on the penetration and use case whether to configure the extended RAR window or not. If considered useful, this can be implemented in the initial phase. Otherwise, UEs may also be upgraded with this capability if enhancements are considered needed.1. Introduce a separate FG for support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0
 |
| [12] | Nokia, Nokia Shanghai Bell | * 10-1/10-1a/10-2/10-2a: Missing clear relationship with 10-30 (COT duration). It should be a pre-requisite at least for 10-1/10-1a.
* 10-1, components 8, 9, 10: remove “with Q” or clarify the text so that it becomes self-contained.
* 10-1a: remove “with Q” or clarify the text so that it becomes self-contained.
* 10-2:
	+ Components 4, 5, 6: remove “with Q” or clarify the text so that it becomes self-contained.
	+ Component 8: add 2ms support
* 10-2a:
	+ Component 1: remove “with Q” or clarify the text so that it becomes self-contained.
	+ Component 2: add 2ms support
* 10-2b: it is unclear why this component would be needed.
 |
| [13] | Qualcomm Incorporated |

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| 10-1 | UE stand-alone (DL and UL) operation in shared spectrum under dynamic channel access mode  | 1. Type 1 channel access2. Type 2A channel access3. Type 2B channel access (FFS if move this to separate feature)4. Type 2C channel access5. 20MHz LBT bandwidth6. Contention window adjustment7. CP extension up to 1 symbol for PUSCH/PUCCH transmission8. SSB/MIB/RMSI reception with Q9. SSB RRM with Q in DMTC10. SSB-RLM with Q in DMTC window11. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0 |  |  | N/A |  | Per band | N/A | N/A |  | This is a basic feature group for operating in unlicensed band with both DL and UL transmission support under dynamic channel access | Optional with capability signalling |
| 10-1a | UE DL only operation in shared spectrum under dynamic channel access mode | 1. SSB RRM with Q in DMTC | 6-5 |  | N/A |  | Per band | N/A | N/A |  | This is a basic feature group for operating in unlicensed band with DL only operation under CA mode | Optional with capability signalling |
| 10-2 | UE stand-alone (DL and UL) operation in shared spectrum under semi-static channel access mode  | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth4. SSB/MIB/RMSI reception with Q5. SSB RRM with Q in DMTC6. SSB-RLM with Q in DMTC window7. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_08. Support fixed frame period of 5ms and 10ms |  |  | N/A |  | Per band | N/A | N/A |  | This is a basic feature group for operating in unlicensed band. | Optional with capability signalling |
| 10-2a | UE DL only operation in shared spectrum under semi-static channel access mode | 1. SSB RRM with Q in DMTC2. Support fixed frame period of 5ms and 10ms | 6-5 |  | N/A |  | Per band | N/A | N/A |  | This is a basic feature group for operating in unlicensed band with DL only operation | Optional with capability signalling |
| 10-2b | UE operation in shared spectrum under semi-static channel access mode with shorter fixed frame periods | 1. Support fixed frame periods shorter than 5ms | 10-2 or 10-2a |  | N/A |  | Per band | N/A | N/A |  |  | Optional with capability signalling |

10-2b: An alternative solution is to merge this back to 10-2 and 10-2a where introducing a component on supported fixed frame period lengths with {5ms, 10ms} as one value and {1ms, 2ms, 2.5ms, 4ms, 5ms, 10ms} as another value |
| [14] | Huawei, HiSilicon | It cannot be excluded that certain UEs may only support one of the above scenarios, e.g. Scenario A (licensed-assisted access) with DL-only. Therefore some UEs may not support uplink on unlicensed band. So any FG that only contains UL components should not be a basic feature group according to approach 1.The discussion on UE feature groups for NR-U is considering defining basic feature groups for the following FGs associated with NR-U operation scenarios: 10-1, 10-1a, 10-2, 10-2a, 10-2b (see Table 1 below). Previously FGs 10-1 and 10-2 were only about UL capabilities, but in the latest version [R1-2001484] DL components were added and certain DL components are repeated in several of those FGs, i.e. SSB RRM with Q in DMTC. This means approach 2 is taken as basis for the proposed definition of basic FGs in [R1-2001484], as this is not consistent with approach 1. However it is unclear if there would be separate capability signaling for the components within FG 10-1 and 10-2, or if all components of FG 10-1 and 10-2 would also need to be individual FGs of their own.Alternatively FG10-1a could be considered a prerequisite of FG10-1, and FG10-2a a prerequisite of FG10-2. The earlier version clearly separating the UL and DL components into different FGs allowed a UE to clearly report those capabilities separately for signaling support for various operation scenarios. With the latest grouping in [R1-2001484], how would a UE signal support for scenario B with dual-connectivity? Would the UE have to support standalone DL and UL in order to support scenario B? If so, why should such constraint be introduced?For DL only operation with SCell in unlicensed band, there are now 2 FGs: one for LBE and one for FBE. If those 2 FGs (10-1a and 10-2a) are considered as basic FGs, then it is clear that it should not be expected that a UE has to report support for both FGs if the UE signals support for band n46. So again, FGs 10-1a and 10-2a as defined in [R1-2001484] can only be considered as basic FGs according to approach 2 in [RP-200502]. If the minimum required for operation on band n46 is considered, according to the current list, it should be SSB RRM with Q in DMTC, and support for FBE comes with one additional capability (support fixed frame period of 5ms and 10ms).***Observation 1:**** ***According to the definition of basic feature group of approach 1 in RP-200502, only a FG10-1a with SSB RRM with Q in DMTC as a single component may qualify as a basic FG for NR-U.***
* ***FGs 10-1, 10-1a, 10-2, 10-2a, 10-2b in R1-2001484 are defined according to the definition of basic feature group of approach 2 in RP-200502.***

***Proposal 1:**** ***RAN1 needs to clearly indicate whether separate capability signaling for each component is expected for FGs 10-1 and 10-2 in R1-2001484.***
* ***RAN1 needs to clarify why certain components are included in multiple NR-U FGs in R1-2001484.***

**Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0**FG10-27 is kept as a separate FG for wideband PRACH (same as RB-interlaced PUSCH and PUCCH), so it is unclear why “*Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0*” was included as a component of FG10-1 and FG10-2. This functionality is for 2-step RACH, so it should be a separate FG because support of 2-step RACH is not a prerequisite for FG10-1 or FG10-2. |
| [15] | TCL Communication | We believe that for NR-Unlicensed, similar to V2X, for the UEs able to interoperate with the network over the shared spectrum using NR-U as standardized in 3GPP Rel-16, the 3GPP should define a set of features which are mandatory for the NR-U capable UEs. This base group of features defines the minimum functionalities which 3GPP deems necessary for unlicensed operation.Without such baseline future interoperability testing will prove difficult and the market will require another level of alignment between vendors.**Proposal 1:**There is a base group of UE features defined among the NR-Unlicensed capabilities which are defined to be mandatory if a UE indicates its capability to operate over shared spectrum. These features shall be group in UE feature 10-1 or 10-2.We believe that NR-U Rel-16 provides for shared spectrum usage what NR Rel-15 provides for Uu opeatrion. For this reason, we believe that it will be useful to define the basic features which may provide certain quality of communication. For this reason, we believe that 10-3 (PRB interlace mapping for PUSCH) should be part of basic feature set which are mandatory for UEs indicating being capable of Rel-16 NR-U operation. For feature 10-25 (Enable configured UL transmission out of COT), we understand the description of this feature as to support CG UL transmissions where UE initiates the COT. If this understanding is correct, and when this feature is not supported, UE will not initiate channel access to make a CG UL transmission. From our perspective, this is very performance inefficient for configured grant operation and this behaviour should be supported as mandatory or among the basic feature groups.Feature 10-16 (One-shot HARQ ACK feedback) is a very important feature. Without this feature, system efficiency is very low due to loss of feedback for many DL packets. For this reason, this should be added as one of the mandatory features to UEs capable of Rel-16 NR-U operation.Similarly, 10-19 (number of LBT bandwidths), this is more of a fundamental feature compared to carrier aggregation. One aspect is related to per band nature, and one other aspect is related to UE processing capability. Independent of the representation, from our perspective, given NR supports upto 100 MHz BW, the basic feature set for NR-U should be the support of BW larger than 20 MHz. This also means that feature 10-29 (support available RB set indicator field in DCI 2\_0) should be supported as mandatory NR-U Rel-16 feature as this signaling in the DCI largely facilitates the effective usage of wideband carrier over the shared spectrum. The feature 10-30 (Support channel occupancy duration indicator field in DCI 2\_0) also provides very basic functionliaty about the channel occupancy representation and utilization over the shared spectrum and thus should be mandatory.From our understanding, following the strategy of making the basic features as components in 10-1 and 10-2, we believe that the best way to ensure meaningful NR-U operation is to add 10-3, 10-25, 10-19, 10-29 and 10-30 as components in the basic features groups of 10-1 and 1-2.**Proposal 2:**Add 10-3, 10-25, 10-19, 10-29, 10-30 and 10-16 as components in 10-1 and 10-2. |

## 2.1 Discussion 1

**Companies are encouraged to provide views on how to define basic FGs to cover all deployment scenarios.**

**Options 1 and 2 stated below are the starting point**

* **Option 1: define new basic FGs in addition to current basic FGs to cover all deployment scenarios (e.g., [3] and [5])**
	+ **Supported by:**
	+ **Objected by:**
* **Option 2: define new basic FGs with components that have tightly related functionality to replace current basic FGs (e.g., [8])**
	+ **Supported by:**
	+ **Objected by:**

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## 2.2 Discussion 2

**Companies are encouraged to provide views on whether or not “Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0” can be separate capability from basic FGs.**

 **Introducing the separated FG supported by:**

 **Objected (i.e., not introducing the separate FG) by:**

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| Company | Comment |
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## 2.3 Discussion 3

**Companies are encouraged to provide views on whether or not “Type 2B channel access” can be separate capability from basic FGs.**

 **Introducing the separated FG supported by:**

 **Objected (i.e., not introducing the separate FG) by:**

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| Company | Comment |
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## 2.4 Discussion 4

**Companies are encouraged to provide views on whether/how FG10-3 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.5 Discussion 5

**Companies are encouraged to provide views on whether/how FG10-11 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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## 2.6 Discussion 6

**Companies are encouraged to provide views on whether/how FG10-14 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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## 2.7 Discussion 7

**Companies are encouraged to provide views on whether/how FG10-15 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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## 2.8 Discussion 8

**Companies are encouraged to provide views on whether/how FG10-16/16a can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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## 2.9 Discussion 9

**Companies are encouraged to provide views on whether/how FG10-17 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.10 Discussion 10

**Companies are encouraged to provide views on whether/how FG10-18 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.11 Discussion 11

**Companies are encouraged to provide views on whether/how FG10-19 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.12 Discussion 12

**Companies are encouraged to provide views on whether/how FG10-20/20a can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.13 Discussion 13

**Companies are encouraged to provide views on whether/how FG10-24 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.14 Discussion 14

**Companies are encouraged to provide views on whether/how FG10-25 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.15 Discussion 15

**Companies are encouraged to provide views on whether/how FG10-28 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.16 Discussion 16

**Companies are encouraged to provide views on whether/how FG10-29 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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## 2.17 Discussion 17

**Companies are encouraged to provide views on whether/how FG10-30 can be included in basic FGs.**

 **Including it as part of basic FG(s) supported by:**

 **Objected (i.e., keeping it as the separated FG) by:**

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| Company | Comment |
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# **Conclusion**

TBD

# **References**

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[5] R1-2001826 Views on Rel-16 UE features for NR-U MediaTek Inc.

[6] R1-2001941 Discussion on UE features for NR-U LG Electronics

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[15] R1-2002683 UE Features for NR-U TCL Communications