**3GPP TSG RAN WG1 #104-e R1-2101834**

**e-Meeting, January 25th – February 5th, 2021**

**Agenda item:** 7.2.11

**Source:** Moderator (NTT DOCOMO, INC.)

**Title:** Summary on [104-e-NR-UEFeature-Others-01]

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the following email discussion.

**Others**

[104-e-NR-UEFeature-Others-01] Email discussion/approval on NR UE features for others (25th Jan – 29th Jan) – Hiroki (DCM)

* Regarding FG22-6/6a/7
	+ Whether or not to add replicated FGs 6-[8/]9/9a to be reported with FG22-7
	+ Whether or not to update how to handle SDL/SUL
	+ Whether or not to confirm the working assumption on how to count SUL
	+ Whether/how to cover the case where the NUL and the SUL are in different FRs or in different licensed/unlicensed types
* Whether/how to update the prerequisite of FG22-8a/b/c/d
* Regarding licensed/unlicensed differentiation for Rel-15 FGs
	+ Confirm the FG descriptions of new FGs to indicate the support of following FG in unlicensed band (as agreed in RAN1#103-e)
		- FG 1-2 (SS block based SINR measurement (SS-SINR))
		- FG 2-32a/2-32b (Semi-persistent CSI report on PUCCH/PUSCH)
		- FG 3-6 (Dynamic SFI monitoring)
		- FG 4-19a/4-19b/4-19c/4-28 (HARQ-ACK multiplexing)
		- FG 4-23 (Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8)
		- FG 5-14/5-16/5-17/5-17a (PDSCH and PUSCH repetitions)
	+ Whether or not to add new FG(s) to indicate the support of following FG in unlicensed band
		- [FG 4-19]
		- [FG 5-18/5-19/5-20/5-21 (SPS and configured grant)]
	+ Whether each of Rel-16 versions of 4-19/4-23/4-28/5-17 is part of basic operation for corresponding scenarios of NR-U
	+ Whether/how to clarify the interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers
1. Discussion on Rel-16 NR UE features for others
	1. Remaining details on FG22-6/6a/7

Following proposals are made in contributions.

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| [6] | From RAN1 #103e, there are two issues to be resolved:

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| Agreements:* Whether to support two PUCCH groups is reported per BC for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}
	+ For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,
		- the “primary PUCCH group config” includes following information:
			* One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the primary PUCCH group
			* One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the primary PUCCH group
		- the “secondary PUCCH group config” includes following information:
			* One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the secondary PUCCH group
			* One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the secondary PUCCH group
		- Note: for each {primary PUCCH group config, secondary PUCCH group config}, each carrier type of {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} is mapped to either or both of the primary PUCCH group config and the secondary PUCCH group config.
	+ Note: RAN1 will discuss on how to handle the SDL or SUL band, for example as below
		- SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly
		- SDL having no overlapped TDD or FDD can follow the same principle with FDD
	+ Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission
		- FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations
	+ Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH group
		- FFS: SUL is counted as number of bands for the condition of this new FG reporting

Working assumption:2nd FFS in above agreements is removed i.e., SUL is counted as number of bands for the condition of this new FG reporting.* This note is added not only for FG22-7 but also for FG22-6/6a
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The first issue is how to handle the SDL or SUL band. From the outcomes in RAN#90e [2]:

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| **Agreement**: No new signalling will be introduced in Rel-16 to provide a DL/UL configuration for an SUL carrier.**Moderator's conclusion:** Per UE Capabilities that are FDD/TDD differentiated when applied to SUL carriers are indicated by the FDD capability (i.e. in effect the capabilities are not FDD/TDD differentiated for this case). Per UE capabilities that are TDD only are not applicable to SUL. RAN2 is tasked to prepare Rel-15 and 16 CRs to capture this agreement. |

The exact scope between [2] and here is a bit different. We used to have a preference in this context was to confirm the note: i.e. SDL/SUL overlapping with either TDD or FDD can follow the same principle with TDD or FDD whereas SDL/SUL having no overlapping TDD or FDD can follow the same principle with FDD. This way can avoid enforcing UE to support a feature supported in TDD only, for instance, does not have to support in SUL. On the other hand, the latest agreements in RAN#90e can also address the concern as well. Thus, we now prefer to have similar principle as agreed in RAN#90e.***Proposal 3:*** * ***In support of two PUCCH groups per BC for NR-CA with 3 or more bands, SDL/SUL will be considered FDD in reporting information in PUCCH group config. Per UE capabilities that are TDD only are not applicable to SDL/SUL.***

The second issue is whether the SUL in the same cell as in the NUL can also be configured for the PUCCH group when the carrier type of NUL is indicated for one PUCCH group config. One of main motivations having the capability for NR-CA with 3 or more bands in this context is to allow UE to provide preference in which carrier PUCCH can be sent. In general, we think the current agreement of UE reporting on supported configuration(s) for primary/secondary PUCCH group config can offer sufficient degree of freedom to UE especially given that single UL Tx operation between SUL and NUL is possible depending on capability signaling. It is questionable for us to further differentiate it between SUL and NUL. Therefore, we prefer SUL can be also configured for PUCCH transmission as in the NUL in the same cell.***Proposal 4:*** * ***The SUL in the same cell as in the NUL can be also be configured for PUCCH transmission when the carrier type of NUL is indicated for PUCCH transmission location.***
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| [7] | As described in R1-2009327, one of discussion items during RAN1#103-e is whether to add new FGs based on 6-8/9/9a in Rel-16. As mentioned before, the current design of 22-7 does not necessarily guarantee at least the same level of signaling flexibility provided in 6-8/9/9a. This is undesirable because the main objective of 22-7 is to improve such signaling flexibility for UE implementation. As an example, consider a BC with {n3, n78, n257}, and consider PUCCH group reporting of 2 possible groupings as {G#1={FR1-FDD, FR1-TDD},G#2={FR2}} and {G#1={FR1-TDD, FR2}, G#2={FR1-FDD}}. Such grouping should not necessarily mean that a UE can support different SCS within a group. For example, a UE may report supported SCS in {n3, n78, n257} as {30kHz, 30kHz, 120kHz} and {30kHz, 60kHz, 60kHz}. In this case, without any extra signaling, this UE would need to support different SCS within a group. With 6-9/9a replicated and if a UE declines it, then {30kHz, 30kHz, 120kHz} can implicitly be linked to {G#1={FR1-FDD, FR1-TDD},G#2={FR2}}, and {30kHz, 60kHz, 60kHz} can implicitly be linked to {G#1={FR1-TDD, FR2}, G#2={FR1-FDD}}. Hence, without extra signaling, flexibility can be even worse than Rel-15.One obvious way of ensuring minimum flexibility is to introduce new FGs based on 6-8/9/9a. Among these, we may not need to replicate 6-8 since a UE not supporting different SCS across groups can express such inability by controlling supported SCS combination in the BC given that utilization of new Rel-16 signaling already implies support of 2 PUCCH groups. In that sense, we propose introduction of new FGs as below.Table 2

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| 22-x | Different numerologies across NR carriers within the same NR PUCCH group, with PUCCH on a carrier of smaller SCS | 1) For NR CA UE, same numerology between DL and UL per carrier for data/control channel at a given time2) For NR CA UE with two NR PUCCH groups, different numerologies across NR carriers up to two different numerologies within the same NR PUCCH group wherein NR PUCCH is sent on the carrier with smaller SCS for data/control channel at a given time | 22-7 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 22-y | Different numerologies across NR carriers within the same NR PUCCH group, with PUCCH on a carrier of larger SCS | 1) For NR CA UE, same numerology between DL and UL per carrier for data/control channel at a given time2) For NR CA UE with two NR PUCCH groups, different numerologies across NR carriers up to two different numerologies within the same NR PUCCH group wherein NR PUCCH is sent on the carrier with larger SCS for data/control channel at a given time | 22-7 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |

***Proposal 2: Introduce two new FGs in Rel-16 as above Table 2 corresponding to FG6-9/9a.*** |
| [8] | In RAN1#103-e a new FG 22-7 has been agreed with the following related working assumption:**Working assumption:**2nd FFS in above agreements is removed i.e., SUL is counted as number of bands for the condition of this new FG reporting.* This note is added not only for FG22-7 but also for FG22-6/6a

**Proposal 4: Confirm the working assumption, i.e. SUL is counted as number of bands for the condition FG reporting in 22-7 and 22-6/6a.**  |
| [10] | In RAN1#103-e meeting, three new FGs are introduced including FG22-6, FG22-6a, FG22-7, in [1]. There are still some note and FFS that needs to be clarified. We provide our view as below**Proposal 2-1: Regarding the Note and FFS for newly introduced FG22-6, FG22-6a, FG22-7*** **For the carrier type of SDL**
	+ **If SDL only overlaps with either TDD or FDD band: it follows the carrier type of the band it overlaps with**
	+ **If SDL overlaps with both TDD and FDD band: it follows FDD**
	+ **If SDL has no overlapped TDD or FDD band: it follows FDD**
* **In future, if SUL can be associated with NUL in different FR, or, in different licensed/unlicensed**
	+ **When the carrier type of NUL is indicated for PUCCH transmission location, for the associated SUL that is in a different FR, or in a different licensed/unlicensed carrier type, UE can further indicate whether UE can support PUCCH transmission location to be configured in SUL**
* **SUL is counted as number of bands for the condition of FG22-7**
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| [11] | **Handling of SDL and SUL**There are still remaining issues captured in the RAN1#103-e agreements for FG22-6, 22-6a, and 22-7:* Note: RAN1 will discuss on how to handle the SDL or SUL band, for example as below
	+ SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly
	+ SDL having no overlapped TDD or FDD can follow the same principle with FDD
* Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission
	+ FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations

Regarding SDL handling, the above first note makes sense – if the SDL is overlapped with either TDD or FDD then the SDL is considered as the corresponding TDD or FDD; otherwise the SDL is considered as an FDD. On the other hand, for SUL, there was an agreement in the RAN plenary meeting that the SUL is considered as and FDD always. To be consistent, this principle can be applied for SUL.The second note has an FFS. To address this, it would be good to consider an example scenario where one PUCCH-group has an FR1-FDD carrier and another PUCCH-group has an FR2 carrier as a NUL and an FR1-SUL carrier that is associated with the NUL. With this configuration, the UE is required to support both of the following:(1) simultaneous PUCCH transmissions on FR1-FDD carrier on the first PUCCH-group and on FR2 carrier on the second PUCCH-group, and (2) simultaneous PUCCH transmissions on FR1-FDD carrier on the first PUCCH-group and on FR1-SUL carrier. This implies that the UE has to have the capability of following two cases. (a) two PUCCH-groups where the PUCCH transmission for the first PUCCH-group can take place on the FR1-FDD carrier and the PUCCH transmission for the second PUCCH-group can take place on FR1-SUL carrier, and (b) two PUCCH-groups where the PUCCH transmission for the first PUCCH-group can take place on the FR1-FDD carrier and the PUCCH transmission for the second PUCCH-group can take place on FR2 carrier. However, the note implies that if the UE indicates support of the NUL-SUL and (b), the UE is required to support (1) and (2), even if the UE does not indicate (a). It should be clarified that the UE is supposed to support the case only if the UE reports appropriate capabilities (a) and (b).**Proposal 1:*** **Confirm the handling of SDL:**
	+ **SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly**
	+ **SDL having no overlapped TDD or FDD can follow the same principle with FDD**
* **Regarding SUL,**
	+ **SUL is considered as FR1-FDD type**
* **Regarding FFS “how to cover licensed/unlicensed and/or FR1/FR2 differentiations” for the second note,**
	+ **If the NUL belongs to the type “FR1 unlicensed TDD” or “FR2” and has the associated SUL, the UE is supposed to support two PUCCH groups where a PUCCH transmission can take place on the NUL or the SUL in a PUCCH group only if the UE indicates support of PUCCH transmission on the type of the NUL and the type of the associated SUL in the PUCCH group**

**Whether to replicate FG6-8, 6-9, and 6-9a**These FGs exists in Rel.15. If these cannot be used with FG22-7, the flexibility improvement of UE implementation according to FG22-7 might be lost. Since the gNB is able to take care of FG6-8, 6-9, and 6-9a reported by Rel.15 UEs, replicating these FGs into Rel.16 does not bring any penalty to the network side. Therefore, we propose to replicate them in Rel.16.**Proposal 2:*** **Replicate FG6-8, 6-9, and 6-9a in Rel.16.**
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| [13] | At the RAN1#103-e meeting, following agreements and working assumption were made regarding new FGs for NR-CA, and FG22-6/6a/7 were added accordingly [1, 3].

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| **Agreements:*** **Define a new FG for support of up to three different numerologies for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups**

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| 22. NR Others | 22-x | Support of up to three different numerologies in the same NR PUCCH group for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups | Support of up to three different numerologies in the same NR PUCCH group for NR-CA where UE is not configured with two NR PUCCH groups 1) Which NR Carrier type(s) that can transmit NR PUCCH  |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Candidate values1) One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission | Optional with capability signalling |

* **Define a new FG for support of up to four different numerologies for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups**

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| 22. NR Others | 22-x | Support of up to four different numerologies in the same NR PUCCH group for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups | Support of up to four different numerologies in the same NR PUCCH group for NR-CA where UE is not configured with two NR PUCCH groups 1) Which NR Carrier type(s) that can transmit NR PUCCH  |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Candidate values1) One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission | Optional with capability signalling |

* Note: These capabilities are indicated independently for each BC of EN-DC, NGEN-DC, NE-DC and NR-CA

**Agreements:*** Whether to support two PUCCH groups is reported per BC for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}
	+ For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,
		- the “primary PUCCH group config” includes following information:
			* **One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}** mapped to the primary PUCCH group
			* **One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}** that can be configured with the PUCCH transmission in the primary PUCCH group
		- the “secondary PUCCH group config” includes following information:
			* **One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}** mapped to the secondary PUCCH group
			* **One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}** that can be configured with the PUCCH transmission in the secondary PUCCH group
		- Note: for each {primary PUCCH group config, secondary PUCCH group config}, **each carrier type of {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}** is mapped to either or both of the primary PUCCH group config and the secondary PUCCH group config.
	+ Note: RAN1 will discuss on how to handle the SDL or SUL band, for example as below
		- SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly
		- SDL having no overlapped TDD or FDD can follow the same principle with FDD
	+ Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission
		- FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations
	+ Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH group
		- FFS: SUL is counted as number of bands for the condition of this new FG reporting

**Working assumption:**2nd FFS in above agreements is removed i.e., SUL is counted as number of bands for the condition of this new FG reporting.* This note is added not only for FG22-7 but also for FG22-6/6a
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| 22. NR Others | 22-6 | Support of up to three different numerologies in the same NR PUCCH group for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups | Support of up to three different numerologies in the same NR PUCCH group for NR-CA where UE is not configured with two NR PUCCH groups 1) Which NR Carrier type(s) that can transmit NR PUCCH  |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Candidate values1. One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission

Note: RAN1 will discuss on how to handle the SDL or SUL band* [SUL is counted as number of bands for the condition of this new FG reporting.]
 | Optional with capability signalling |
| 22. NR Others | 22-6a | Support of up to four different numerologies in the same NR PUCCH group for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups | Support of up to four different numerologies in the same NR PUCCH group for NR-CA where UE is not configured with two NR PUCCH groups 1) Which NR Carrier type(s) that can transmit NR PUCCH  |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Candidate values1. One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission

Note: RAN1 will discuss on how to handle the SDL or SUL band* [SUL is counted as number of bands for the condition of this new FG reporting.]
 | Optional with capability signalling |
| 22. NR Others | 22-7 | Support two PUCCH groups for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} | For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,* + the “primary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the primary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the primary PUCCH group
	+ the “secondary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the secondary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the secondary PUCCH group
	+ Note: for each {primary PUCCH group config, secondary PUCCH group config}, each carrier type of {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} is mapped to either or both of the primary PUCCH group config and the secondary PUCCH group config.
 |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Note: RAN1 will discuss on how to handle the SDL or SUL band, for example as below* SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly
* SDL having no overlapped TDD or FDD can follow the same principle with FDD

Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission* FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations

Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH group* [SUL is counted as number of bands for the condition of this new FG reporting]
 | Optional with capability signalling |

However, there was no consensus on following proposals even after extensive discussion in the last meeting [3].

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| **Proposed working assumption:**The new FGs based on 6-[8]/9/9a are also introduced in Rel-16.* The UE may report the new FGs (if necessary) only if the UE also reports the FG22-7.
* Detailed field description and condition of reporting the new FGs are FFS

**Proposed working assumption:**1st FFS in above agreement is removed and the note can be updated as follows. * Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission, except when the NUL and the SUL are in different FRs or in different licensed/unlicensed types
	+ If the NUL and the SUL in a PUCCH-group are in different FRs or in different licensed/unlicensed types, for PUCCH-grouping capability;
		- the UE reports support of following two PUCCH-grouping configurations:
			* The PUCCH-group for the NUL that has the type {FR1-FDD, FR1-TDD, unlicensed, FR2} of the NUL as the type for PUCCH transmission and the other PUCCH-group configuration not for the NUL, and;
			* The PUCCH-group that has the type {FR1-FDD, FR1-TDD, unlicensed, FR2} of the SUL as the type for PUCCH transmission and the other PUCCH-group configuration not for the NUL, where;
			* The type {FR1-FDD, FR1-TDD, unlicensed, FR2} of the SUL is determined based on {FR1-xDD, unlicensed, FR2}, where FR1-xDD is deteremined based on the TDD/FDD of the overlapping band.
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View* For replication of FG 6-8/9/9a, we are supportive of the direction. FG 6-8/9/9a are capabilities related to PUCCH group, with reporting flexibility from SCS perspective. Meanwhile, FG 22-7 agreed at the last meeting is a capablility related to PUCCH group, with reporting flexibility from carrier-type perspective. To have both of the reporting flexibilities, original FG 6-8/9/9a cannot be used appropriately with FG 22-7 since NW side misunderstands as UE supporting any PUCCH grouping if the base station is Rel-15 version. Introducing the replicated FG 6-8/9/9a can solve such issue since UE would not report the original FG 6-8/9/9a and can report its capability with sufficient flexibility from both carrier type and SCS perspectives. In addition, we think that sufficient reporting flexibility in this release can avoid similar discussion in future release.
* Regarding replication of FG 6-8, which is set with brackets, the brackets should be removed and replication of FG 6-8 would also be necessary in our view. For example, UE would report supporting PUCCH grouping as ({FR1 licensed TDD, FR1 unlicensed TDD), {FR1 licensed FDD}}, but only SCS = 30 kHz is supported. In this case, original FG 6-8 + FG 22-7 can indicate this, but Rel-15 NW misunderstands UE’s supported PUCCH grouping as abovementioned. Even if this case is assumed as corner case, completed capability signaling would help RAN1 work in future release.
* For SUL count, we are fine to remove the brackets, i.e., we can confirm the working assumption.
* For the proposed working assumption on the case where the NUL and the SUL are in different FRs or in different licensed/unlicensed types, we have no strong opinion but the proposed working assumption could address FFS point of the previous agreements. So, we would be fine with the proposed working assumption.
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| [15] | As in our contribution [2] last RAN1 meeting, the specific per-UE capabilities with suffix of XDD-Diff and the reason for the UE reporting different values for TDD/FDD on those capabilities is provided as below: **Table 1. *Phy-ParametersXDD-Diff* field components and the reason for xDD differentiation respectively**

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| **UE Capability** | **Reason for xDD differentiation** |
| *dynamicSFI* | SFI for TDD/FDD is different |
| *twoPUCCH-F0-2-ConsecSymbols* | For IoDT consideration |
| *twoDifferentTPC-Loop-PUSCH* | For IoDT consideration |
| *twoDifferentTPC-Loop-PUCCH* | For IoDT consideration |
| *dl-SchedulingOffset-PDSCH-TypeA* | For IoDT consideration |
| *dl-SchedulingOffset-PDSCH-TypeB* | For IoDT consideration |
| *ul-SchedulingOffset* | For IoDT consideration |

Note that although there are two SDL bands overlapping with TDD bands, i.e., n75 SDL band overlapping with n50 TDD band and n76 SDL band overlapping with n51 TDD band, all the subframes on SDL are designated for downlink transmission, which is the same as an FDD downlink carrier. Thus from the IoDT perspective, the FDD IoDT results could be the same for SDL, and SDL has also followed the same SFI mechanism as FDD. In conclusion, we think the FDD capability indication for SUL when applying per UE capabilities can be reused for SDL.***Proposal****:* *Regarding all the per-UE capabilities within Phy-ParametersXDD-Diff field differentiated by FDD and TDD both in Rel-15 and Rel-16, FDD capability indication is always considered for SDL bands.* |

Based on the above proposals, following point can be discussed in RAN1#104-e meeting.

**Discussion point #2**

* **Regarding FG22-6/6a/7**
	+ **Whether or not to add replicated FGs 6-[8/]9/9a to be reported with FG22-7**
	+ **Whether or not to update how to handle SDL/SUL**
	+ **Whether or not to confirm the working assumption on how to count SUL**
	+ **Whether/how to cover the case where the NUL and the SUL are in different FRs or in different licensed/unlicensed types**

Companies’ views in the contributions can be summarized as below.

* **Add replicated FGs 6-9/9a to be reported with FG22-7**
	+ **Support: Samsung, Qualcomm, DOCOMO**
* **Add replicated FGs 6-8 to be reported with FG22-7**
	+ **Support: Qualcomm, DOCOMO**
	+ **Not support: Samsung**
* **Confirm the working assumption that SUL is counted as number of bands for the condition of FG22-6/6a/7**
	+ **Support: Nokia/NSB, Apple, DOCOMO**
* **Regarding FFS “how to cover licensed/unlicensed and/or FR1/FR2 differentiations” for the second note,**
	+ **If the NUL belongs to the type “FR1 unlicensed TDD” or “FR2” and has the associated SUL, the UE is supposed to support two PUCCH groups where a PUCCH transmission can take place on the NUL or the SUL in a PUCCH group only if the UE indicates support of PUCCH transmission on the type of the NUL and the type of the associated SUL in the PUCCH group**
		- **Support: Apple, Qualcomm, DOCOMO**
	+ **The SUL in the same cell as in the NUL can be also be configured for PUCCH transmission when the carrier type of NUL is indicated for PUCCH transmission location.**
		- **Support: Intel**
* **Regarding how to handle SDL**
	+ **SDL is considered as FDD (following RAN1#90 conclusion for SUL): Intel, Huawei/HiSi**
	+ **SDL is handled as below: Apple, Qualcomm**
		- **If SDL only overlaps with either TDD or FDD band: it follows the carrier type of the band it overlaps with**
		- **If SDL overlaps with both TDD and FDD band: it follows FDD**
		- **If SDL has no overlapped TDD or FDD band: it follows FDD**
* **Regarding how to handle SUL**
	+ **SUL is considered as FDD**
		- **Support: Intel, Qualcomm**

Based on above, following four FL proposals can be made.

**FL proposal 1:**

* **Add replicated FGs 6-9/9a to be reported with FG22-7**
* **Add replicated FGs 6-8 to be reported with FG22-7**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | Support both bullets.For FG 6-8, replication would be necessary. UE would report supporting PUCCH grouping as ({FR1 licensed TDD, FR1 unlicensed TDD), {FR1 licensed FDD}}, but only SCS = 30 kHz is supported. In this case, original FG 6-8 + FG 22-7 can indicate this, but Rel-15 NW misunderstands UE’s supported PUCCH grouping as abovementioned. |
| Apple | Support both bullets |
| Samsung | We support the first bullet to guarantee at least the same level of flexibility as rel-15, and we also provided an exemplary form of new FG description. Regarding the second bullet, we do not have a strong view, but the main reason we think it is not must since it can be done implicitly by supported SCS combination which is per-FSPC if a UE only wants to support the same numerology across groups. Having said that, this then implies that even FG6-8 technically was not necessary in rel-15, so we are OK to replicate this given that a similar thing already happened in rel-15. |
| Ericsson | As a general comment, the examples given do not seem to address a critical usecase, so whether this new capability needs to be introduced after Rel-16 ASN.1 freeze should also be considered. We would like to review the new proposed FG directly as opposed to above FL proposal 1. We do not think ‘replication’ should be used since the components of the new proposed FG are not expected to be identical to FG 6-9/9a. |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, we may need to discuss on the descriptions of proposed new FGs.So, FL proposal 1 can be updated and further discussed. |

### **Updated FL proposal 1:**

* **Add new FGs based on 6-8/9/9a to be reported with FG22-7 as below**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 22. NR Others | 22-7a | Different numerology across NR PUCCH groups | For UE supporting two PUCCH groups for CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}, different numerology between two NR PUCCH groups for data/control channel at a given time | 22-7 | Yes | N/A |  | Per BC | N/A | N/A  | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-7b | Different numerologies across NR carriers within the same NR PUCCH group, with PUCCH on a carrier of smaller SCS | For UE supporting two PUCCH groups for CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}, different numerologies across NR carriers up to two different numerologies within the same NR PUCCH group wherein NR PUCCH is sent on the carrier with smaller SCS for data/control channel at a given time | 22-7 | Yes | N/A |  | Per BC | N/A | N/A  | N/A | The terminologies 'UL' and 'carrier' in this FG do not refer to 'SUL'. NR PUCCH is sent on a carrier with SCS not larger than SCS of any DL carriers corresponding to the NR PUCCH group. | Optional with capability signaling |
| 22. NR Others | 22-7c | Different numerologies across NR carriers within the same NR PUCCH group, with PUCCH on a carrier of larger SCS | For UE supporting two PUCCH groups for CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}, different numerologies across NR carriers up to two different numerologies within the same NR PUCCH group wherein NR PUCCH is sent on the carrier with larger SCS for data/control channel at a given time | 22-7 | Yes | N/A |  | Per BC | N/A | N/A  | N/A | The terminologies 'UL' and 'carrier' in this FG do not refer to 'SUL'.NR PUCCH is sent on a carrier with SCS not smaller than SCS of any DL carriers corresponding to the NR PUCCH group. | Optional with capability signaling |

* **Update FG22-7 as below**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 22. NR Others | 22-7 | Support two PUCCH groups for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} | For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,* + the “primary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the primary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the primary PUCCH group
	+ the “secondary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the secondary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the secondary PUCCH group
	+ Note: for each {primary PUCCH group config, secondary PUCCH group config}, each carrier type of {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} is mapped to either or both of the primary PUCCH group config and the secondary PUCCH group config.
 |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Note: RAN1 will discuss on how to handle the SDL or SUL band, for example as below* SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly
* SDL having no overlapped TDD or FDD can follow the same principle with FDD

Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission* FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations

Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH groupFFS: SUL is counted as number of bands for the condition of this new FG reportingNote: If UE indicating this FG does not support FG 22-7a, the UE can only be configured with the same SCS across NR PUCCH groups. | Optional with capability signalling |

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| CATT | With above FGs, a UE indicating FG 22-7 can only be configured with the same SCS across NR PUCCH groups and within the same NR PUCCH group. Is that the correct understanding? If yes, it seems FG 22-7 shall be updated as well. |
| ZTE | In principle, we are supportive to introduce new FGs 6-8/6-9/9a to be reported with FG22-7. |
| Huawei, HiSilicon | We would like to remind that the note “The terminologies 'UL' and 'carrier' in this FG do not refer to 'SUL'.” should be copied from FG 6-9/9a to here. Some wording refinement may be needed. |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks and discussion in GTW session.Let’s continue the discussion with considering how to handle SUL as discussed in other FL proposals. |
| NTT DOCOMO | Based on our views provided for FL proposal 2 and 3, the note ‘The terminologies 'UL' and 'carrier' in this FG do not refer to 'SUL'’ should be modified so that at least SUL carrier type is counted for the condition of the new FGs as well as for the FG22-7. |
| Intel | We agree that the notes need to be updated once FL proposal 2 and 3 are agreed. |
| Huawei, HiSilicon | Thank you for the discussions.We have the following updates.* SUL band is counted as one of bands for FG 22-7/22-7a/7b/7c.
* The note “The terminologies 'UL' and 'carrier' in this FG do not refer to 'SUL'.” is outdate now because there is no UL or carrier in the description as the first bullet of 6-9/9a anymore. It can be deleted.
 |
|  |  |

### **FL proposal 2:**

* **Confirm the working assumption that SUL is counted as number of bands for the condition of FG22-6/6a/7**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | Support. |
| Nokia, NSB | We support the FL proposal |
| Apple | We can support |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, FL proposal 2 seems acceptable.So, let’s try to make it agreement in GTW session on Tuesday. |
| ZTE | We are ok with the FL proposal. |
| Huawei, HiSilicon | Thanks for the proposal. The working assumption should be clarified first before confirmation.In our understanding, the working assumption has NBC issue for the following reasons,* In case of a BC with 2 FDD/TDD bands plus one or more SUL band, it causes potential NBC issue. For a UE reporting a combination of two bands, e.g. Example1: {FDD lic#1 and TDD lic#1}, this new FG 22-7 is not reported by the UE as the main bullet of the agreement because this case has been covered by Rel-15 capability well. With the same reason, if one SUL band is added, i.e. Example2: {FDD lic#1 and TDD lic#1 and SUL}, the case has been also covered by Rel-15 capability, the UE should not report the new FG 22-7 with potential NBC issue. Even if two more SUL bands are added, i.e. Example3: {FDD lic#1 and TDD lic#1 and SUL#1 and SUL#2}, the UE should not report the new FG 22-7.
* In case of a BC with three FDD/TDD bands plus one or more SUL bands, the two notes have been agreed to apply the same reported value of NUL to SUL, which means the values reported by a UE for this FG is the same for both the case of three FDD/TDD bands only and the case of three FDD/TDD bands plus one or more SUL bands, e.g. BC {FDD lic#1, TDD lic#1 and TDD lic#2} and BC {FDD lic#1, TDD lic#1 and TDD lic#2 and SUL} have the same reported value for this FG. Therefore, it has meant the SUL is not counted as number of bands for the condition of this new FG reporting. I
	+ *Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission*
		- *FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations*
	+ *Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH group*
		- *FFS: SUL is counted as number of bands for the condition of this new FG reporting*
* Regarding FG22-6/6a, the note is unclear for it because there is no band counting in FG 22-6/6a description. Please clarify it.

Additionally, we would like to ask companies which the following understandings is **correct for SDL*** Understanding#1: BC {FDD lic#1 and TDD lic#1} has been supported by Rel-15 capability instead of the new FG 22-7, similarly, BC {FDD lic#1 and TDD lic#1 and SDL} has also been supported by Rel-15 capability. Reporting the new FG 22-7 is redundant for this case because there is only two bands having UL carriers.
* Understanding#2: BC {FDD lic#1 and TDD lic#1} has been supported by Rel-15 capability instead of the new FG 22-7, however, BC {FDD lic#1 and TDD lic#1 and SDL} should be reported by this new FG even though nothing new can be reported by this FG because there are only two bands having UL carriers.

We feel that the understanding#1 can avoid potential NBC issue and it is correct.Therefore, we propose***Proposal:*** *Confirm the working assumption that SUL is NOT counted as number of bands for the condition of FG22-7** *E.g. FG22-7 is not applicable to a band combination of {FDD license band#1,TDD license band#1, SUL} which can be reported by Rel-15 capability*

***Proposal:*** *SDL is NOT counted as number of bands for the condition of FG22-7** *E.g. FG22-7 is not applicable to a band combination of {FDD license band#1,TDD license band#1, SDL} which can be reported by Rel-15 capability*
 |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks and discussion in GTW session.Let’s continue the discussion with considering comments in GTW session, e.g., there is no NBC issue related to this proposal since UE can under-report its Rel-15 capability but can report Rel-16 capability. |
| NTT DOCOMO | SDL can be discussed in FL proposal 4, and hence here we focus on SUL.In case that SUL and associated NUL have the same carrier type, there would be no issue to follow Rel-15 principle of SUL handling, i.e., SUL is not counted as ‘UL’ or ‘carrier’.However, we think that in case that SUL and associated NUL have different carrier types, reporting flexibility on the support of PUCCH transmission on SUL carriery type and on NUL carrier type would be beneficial as we commented on FL proposal 3.Whether or not to count SUL as number of bands for the condition of FG22-7, we don’t have a strong view since we assume the counting would be based on the number of DL bands for the condition of FG22-7.But SUL carrier type should be counted as number of carrier types for the condition of FG22-7. |
| Huawei, HiSilicon | Thank you for the online and continue offline discussions.We are ok to confirm the working assumption that SUL is counted as number of bands for the condition of FG22-6/6a/7. |

### **FL proposal 3:**

* **Regarding FFS “how to cover licensed/unlicensed and/or FR1/FR2 differentiations” for the second note,**
	+ **If the NUL belongs to the type “FR1 unlicensed TDD” or “FR2” and has the associated SUL, the UE is supposed to support two PUCCH groups where a PUCCH transmission can take place on the NUL or the SUL in a PUCCH group only if the UE indicates support of PUCCH transmission on the type of the NUL and the type of the associated SUL in the PUCCH group**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | OK with the proposal. |
| Nokia, NSB | We support the FL proposal |
| Apple | Support |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, FL proposal 3 seems acceptable.So, let’s try to make it agreement in GTW session on Tuesday. |
| ZTE | We are ok with the FL proposal. |
| Huawei, HiSilicon | Not OK with the proposal. Because in Rel-15 as long as a UE indidicates a band combination of SUL and NUL, e.g. a BC of SUL 1.8GHz and NUL 3.5GHz, PUCCH can be configured on either SUL or NUL without requiring additional UE capability. In other word, which one UL of one given cell can be configured with SUL does not reply on a UE capability for multiple cells. A change to such legacy characteristic can cause NBC issue because SUL and NUL belongs to the same cell rather than two cells like CA. For the example provided in [11], i.e. FR1 FDD band#1, FR1 SUL band and FR2 TDD band, its UE capability reporting has been supported by the current Rel-15 FG 6-7, 6-8 and 6-16. We don’t feel the need to have a new UE FG for it.For an extended example, i.e. FR1 FDD band#1, FR1 FDD band#2, FR1 SUL band and FR2 TDD band, there are two possible UE implementation1. Support PUCCH group#1 on FR1 FDD band and PUCCH group#2 on FR2 TDD band, **but not** support both PUCCH group on FR1 band
2. Support PUCCH group#1 on FR1 FDD band and PUCCH group#2 on FR2 TDD band, **and also** support both PUCCH group on FR1 band

In our understanding, the solution is that only the second UE can report a BC with SUL, while the first UE just simply does not report a support of such a BC with SUL. This solution is much cleaner and plainer than the FL proposal.With this understanding, we already have the two agreed notes* + *Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission*
		- *FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations*
	+ *Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH group*
		- *FFS: SUL is counted as number of bands for the condition of this new FG reporting*
 |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks and discussion in GTW session.Let’s continue the discussion with considering following alternatives.* **Regarding FFS “how to cover licensed/unlicensed and/or FR1/FR2 differentiations” for the second note,**
	+ **If the NUL belongs to the type “FR1 unlicensed TDD” or “FR2” and has the associated SUL, the UE is supposed to support two PUCCH groups where a PUCCH transmission can take place on the NUL or the SUL in a PUCCH group only if the UE indicates support of PUCCH transmission on the type of the NUL and the type of the associated SUL in the PUCCH group**
	+ **The SUL in the same cell as in the NUL can be also be configured for PUCCH transmission when the carrier type of NUL is indicated for PUCCH transmission location.**
 |
| NTT DOCOMO | In case that SUL and associated NUL have different carrier types, it may be good for UE to have flexibility of reporting its support of PUCCH transmission on SUL carrier type and on NUL carrier type separately in order to avoid under-reporting issue. Although there may not be a critical case of such issue at this moment, introducing sufficient flexibility in Rel-16 may be able to avoid potential future discussion due to under-reporting issue.Therefore, we prefer to agree on the original FL proposal 3. |
| Huawei, HiSilicon | To avoid under-reporting issue as NTT DoCoMo commented and the issue raised by Qualcomm, we propose explicite indication of SUL carrier with respect to PUCCH grouping and PUCCH carrier, with the two existing note still applicable to FR1 license NUL, therefore, we have the following proposal to address it,***Proposal:*** *for FG 22-7,* * *Add carrier type “SUL” for both PUCCH group mapping and PUCCH transmission indication.*
* *Based on the agreed two notes for SUL, add a note that if the NUL in the same cell with a SUL belongs to FR1 license band and its carrier type has been indicated in a PUCCH groupd or PUCCH transmission indication, the carrier type “SUL” shall be indicated in the same PUCCH group or PUCCH transmission, respectively.*
* *Carrier type “SUL” is not added as a condition of the description of the feature group, i.e. no change to “Support two PUCCH groups for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}”*
 |

**FL proposal 4:**

* **Regarding how to handle SDL, adopt one of following alternatives**
	+ **Alt.1: SDL is considered as FDD**
	+ **Alt.2: SDL is handled as below**
		- **If SDL only overlaps with either TDD or FDD band: it follows the carrier type of the band it overlaps with**
		- **If SDL overlaps with both TDD and FDD band: it follows FDD**
		- **If SDL has no overlapped TDD or FDD band: it follows FDD**
* **Regarding how to handle SUL**
	+ **SUL is considered as FDD**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | Alt 1 is preferable if there is no/little issue; otherwise, Alt 2 is fine for us. |
| Apple | We support SUL as FDD, for SDL, we do not have strong preference with Alt 1/2 |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.It seems more inputs are helpful to select Alt.1 or 2.If there is no strong preference between them among companies, we can decide one of them based on short discussion in GTW session on Tuesday. |
| ZTE | For SDL, we prefer Alt.2. One question to be clarified is whether the clarification about SDL only applies to FG22-6/6a/7, or is more general and can be applied to all UE features, e.g., UE features with TDD/FDD differentiation.For SUL, it is fine to be considered as FDD, which is aligned with RAN conclusion. |
| Samsung | Our preference is Alt.2 because we think it can address Rel-15 situations well where SDL overlaps with TDD band. But, if majority supports Alt.1, we can accept it because we want this issue to be fixed in this meeting. |
| Huawei, HiSilicon | The proposal is coupled with FL proposal 1 and 2. We prefer to conclude proposal 1 and 2 first before discussing this.Since SUL is not counted as a number of bands for the condition of FG22-6/6a/7 and two notes for SUL have been agreed, the reported values of FG 22-7 have clearly indicated whether SUL can be configured with PUCCH transmission and to which PUCCH group. It would be better to clarify why the proposal “SUL is considered as FDD” is needed.Besides, the wording “SUL is considered as FDD” is misleading, it seems to mean that “FG 22-7 when applied to SUL carriers are indicated by the FDD capability”, however, this meaning is not in line with the two agreed notes.* + *Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission*
		- *FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations*
	+ *Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH group*
		- *FFS: SUL is counted as number of bands for the condition of this new FG reporting*
 |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks and discussion in GTW session.Let’s continue the discussion on following updated FL proposal 4 based on the discussion in GTW session. |

### **Updated FL proposal 4:**

* **Regarding how to handle SDL,**
	+ **[SDL is counted as the number of bands for the condition of FG22-7]**
	+ **SDL is considered as FDD**
		- **Note: Per UE capabilities that are TDD only are not applicable to SDL**
* **Regarding how to handle SUL**
	+ **SUL is considered as FDD**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We support the updated FL proposal 4. In addition, SDL should be counted as the number of bands for the condition of FG22-7 otherwise in case of CA with 3 bands including 1 SDL band, the new FG22-7 cannot be used and PUCCH grouping for both (band A+SDL, band B) and (band A, band B+SDL) would need to be supported to indicate the support of two PUCCH groups using Rel-15 capability. |
| Apple | We support FL proposal We also support to remove/confirm the bracket |
| Intel | Support updated FL proposal 4.The same note as in SDL (*Note: Per UE capabilities that are TDD only are not applicable to SDL*) needs to be added for SUL. |
| Huawei, HiSilicon | Thank you for the online and succeeding offline discussionsRegarding SUL, we propose alternative solution in our reply to proposal 3.Regarding SDL, we prefer Alt.1 but the wording should be clearer that it is only about UE capability indication perspective. Take the RAN#90e agreement as a baseline, we propose,***Proposal****: FG 22-7 capability when applied to SDL carriers are indicated by carrier type “FR1 licensed FDD”* We are fine to count SDL as the number of bands for the condition of FG 22-7.Regarding Intel’s proposed note for SUL, please note that it has been covered in the agreement of RAN#90e |

* 1. Prerequisite of FG22-8a/b/c/d

Following proposals are made in contributions.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| [8] | In RAN1#103-e the following FG has been introduced: Table 1: Definitinon of FG22-8 (relevant fields only)

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 22-8 | For SRS for CB PUSCH and antenna switching on FR1 with symbol level offset for aperiodic SRS transmission   | For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission | 2-53 |

Given that the FG above introduces a constraint on how soon aperiodic SRS can be transmitted after it has been triggered by the gNB, there was a need to introduce updated versions of FGs 3-2, 3-5, 3-5a, and 3-5b as well. This has been done with introduction of FGs 22-8a/b/c/d. The envisioned operation is then as follows:1. UE requires the 19-symbol gap between triggering of aperiodic SRS and SRS transmission under the conditions described in FG 22-8: UE indicates support of 22-8 and it does not indicate support of FGs 3-2, 3-5, 3-5a, or 3-5b. Instead, it may indicate any of 22-8a/b/c/d, if needed.
2. UE does not require the 19-symbol gap between triggering of aperiodic SRS and SRS transmission under the conditions described in FG 22-8: UE does not indicate support of 22-8, and it may indicate support of Rel-15 FGs 3-2, 3-5, 3-5a, or 3-5b, if needed.

Unfortunately, this is not supported by the current definition of FGs 22-8a/b/c/d, as currently the UE supporting any of 22-8a/b/c/d needs to indicate support of the corresponding Rel-15 FGs as well. This implies that the NBC issue that was supposed to be resolved by introduction of 22-8a/b/c/d is still present in current version of UE feature list, as shown in the table below (emphasis ours):Table 2: Definition of FGs 22-8a/b/c/d (relevant fields only)

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 22-8a | PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-2
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-2, 2-53 |
| 22-8b | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5, 2-53 |
| 22-8c | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a DCI gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5a
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5a, 2-53 |
| 22-8d | All PDCCH monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a span gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5b
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5b, 2-53 |

In order to resolve the situation presented above the description of 22-8/a/b/c/d need to be updated to incorporate the contents of the corresponding Rel-15 FGs, and those FGs should be removed from the pre-requisites. This can be implemented as follows, with all definitions of Rel-15 components copied directly from [2, 3]:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 22. NR Others | 22-8a | PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * ~~A UE supports FG 3-2~~
1. For a given UE, all search space configurations are within the same span of 3 consecutive OFDM symbols in the slot
2. For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | ~~3-2,~~ 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-8b | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * ~~A UE supports FG 3-5~~
1. For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2
2. For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | ~~3-5,~~ 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-8c | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a DCI gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * ~~A UE supports FG 3-5a~~
1. For type 1 CSS with dedicated RRC configuration, type 3 CSS and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2, with minimum time separation (including the cross-slot boundary case) between two DL unicast DCIs, between two UL unicast DCIs, or between a DL and an UL unicast DCI in different monitoring occasions where at least one of them is not the monitoring occasions of FG-3-1, for a same UE as
* 2OFDM symbols for 15kHz
* 4OFDM symbols for 30kHz
* 7OFDM symbols for 60kHz with NCP
* 11OFDM symbols for 120kHz
1. Up to one unicast DL DCI and up to one unicast UL DCI in a monitoring occasion except for the monitoring occasions of FG 3-1.
2. In addition for TDD the minimum separation between the first two UL unicast DCIs within the first 3 OFDM symbols of a slot can be zero OFDM symbols.
3. For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | ~~3-5a,~~ 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-8d | All PDCCH monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a span gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * ~~A UE supports FG 3-5b~~

PDCCH monitoring occasions of FG-3-1, plus additional PDCCH monitoring occasion(s) can be any OFDM symbol(s) of a slot for Case 2, and for any two PDCCH monitoring occasions belonging to different spans, where at least one of them is not the monitoring occasions of FG-3-1, in same or different search spaces, there is a minimum time separation of X OFDM symbols (including the cross-slot boundary case) between the start of two spans, where each span is of length up to Y consecutive OFDM symbols of a slot. Spans do not overlap. Every span is contained in a single slot. The same span pattern repeats in every slot. The separation between consecutive spans within and across slots may be unequal but the same (X, Y) limit must be satisfied by all spans. Every monitoring occasion is fully contained in one span. In order to determine a suitable span pattern, first a bitmap b(l), 0<=l<=13 is generated, where b(l)=1 if symbol l of any slot is part of a monitoring occasion, b(l)=0 otherwise. The first span in the span pattern begins at the smallest l for which b(l)=1. The next span in the span pattern begins at the smallest l not included in the previous span(s) for which b(l)=1. The span duration is max{maximum value of all CORESET durations, minimum value of Y in the UE reported candidate value} except possibly the last span in a slot which can be of shorter duration. A particular PDCCH monitoring configuration meets the UE capability limitation if the span arrangement satisfies the gap separation for at least one (X, Y) in the UE reported candidate value set in every slot, including cross slot boundary.For the set of monitoring occasions which are within the same span:* Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for FDD
* Processing one unicast DCI scheduling DL and two unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD
* Processing two unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD

The number of different start symbol indices of spans for all PDCCH monitoring occasions per slot, including PDCCH monitoring occasions of FG-3-1, is no more than floor(14/X) (X is minimum among values reported by UE).The number of different start symbol indices of PDCCH monitoring occasions per slot including PDCCH monitoring occasions of FG-3-1, is no more than 7.The number of different start symbol indices of PDCCH monitoring occasions per half-slot including PDCCH monitoring occasions of FG-3-1 is no more than 4 in SCell.For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission    | ~~3-5b,~~ 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a | This capability is necessary for each SCS.Candidate value set for (X, Y):{(7, 3), (4, 3) and (7, 3), (2, 2) and (4, 3) and (7, 3)} | Optional with capability signalling |

***Proposal 1: Adopt the modified FG definitions in Table 3 for FGs 22-8a/b/c/d.******Proposal 2: Send LS to RAN2 informing them about the updated definitions.*** |
| [13] | At the RAN1#103-e meeting, following agreements were made, and FG22-8/8a/8b/8c/8d were added accordingly [1, 3].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Agreements:*** **Define new FGs for requiring an offset between the end of PDCCH triggering A-SRS and the SRS transmission for CB PUSCH and antenna switching as below**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 22-x | For SRS for CB PUSCH and antenna switching on FR1 with symbol level offset for aperiodic SRS transmission   | For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission | 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22-xa | PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-2
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-2, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22-xb | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22-xc | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a DCI gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5a
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5a, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22-xd | All PDCCH monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a span gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5b
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5b, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |

 |

View* However, prerequisite FGs for 22-8a/b/c/d might be wrong since the intention for introducing these replicated FGs is to allow UE to report the support of advanced PDCCH monitoring capability with constrained timeline for SRS for CB PUSCH and antenna switching on FR1 while reporting no support of original advanced PDCCH monitoring capability. So, FG 22-8a/b/c/d should not have original advanced PDCCH monitoring capability as prerequisite FG.
* Since FG22-8a/b/c/d were already introduced in Dec. version of Rel-16 specification [4], just removing prerequisite FG would cause NBC issue. Therefore, it may be necessary to introduce another set of replicated FGs without original advanced PDCCH monitoring capability as prerequisite FG and to dummify FG22-8a/b/c/d.
 |

Based on the above proposals, following point can be discussed in RAN1#104-e meeting.

**Discussion point #3**

* **Whether/how to update the prerequisite of FG22-8a/b/c/d**

Companies’ views in the contributions can be summarized as below.

* **Update the prerequisite of FG22-8a/b/c/d to remove 3-2/5/5a/5b**
	+ **Support: Nokia/NSB**
* **Introduce replicated FGs of FG22-8a/b/c/d with removeing 3-2/5/5a/5b from prerequisite FGs, and ask RAN2 to dummify FG22-8a/b/c/d**
	+ **Support: DOCOMO**

Based on above, following FL proposals can be made.

**FL proposal 5:**

* **Adopt one of following alternatives**
	+ **Alt.1: Update the prerequisite of FG22-8a/b/c/d to remove 3-2/5/5a/5b**
	+ **Alt.2: Introduce replicated FGs of FG22-8a/b/c/d with removeing 3-2/5/5a/5b from prerequisite FGs, and ask RAN2 to dummify FG22-8a/b/c/d**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We propose Alt.2 assuming that updating prerequisite FG of existing capability at this timing may cause NBC issue. So, if it is not the case, we are also fine with Alt.1 and basically consistent handling for updating prerequisite FG of existing capability is preferable. |
| Nokia, NSB | From RAN1 point of view it should be enough to revise the FGs and let RAN2 decide what is the best way to capture those in RRC, e.g. dummifying the old FGs if needed. However, just removing the pre-requisites is not enough, the FG definitions needed to revised otherwise they are incomplete and unclear.  |
| Samsung | We support the proposal in principle, and alternatives can be further discussed. |
| Ericsson | Agree with Nokia that RAN2 can decide on the dummification or not and that the FG definitions should be revised. Since it may not be crystal clear that removing 3-2/5/5a/5b as prerequisite means that these are added into 22-8a/b/c/d rather than removing their functionality as a prerequisite, can we say:**Proposal*** Update the prerequisite of FG22-8a/b/c/d to remove 3-2/5/5a/5b and to incorporate a copy of each of FG 3-2, 3-5, 3-5a, and 3-5b into each of FG 22-8a, 22-8b, 22-8c, and 22-8d, respectively.
 |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, the principle of FL proposal 5 seems acceptable.Regarding the handling of updating prerequisite FG of existing capability, we can ask RAN2 to decide as Nokia/Ericsson commented.So, FL proposal 5 can be updated accordingly. |

**Updated FL proposal 5:**

* **Components descriptions of FG22-8a/b/c/d are revised as in R1-2101249 to incorporate a copy of each of FG 3-2, 3-5, 3-5a, and 3-5b into each of FG 22-8a, 22-8b, 22-8c, and 22-8d, respectively**
* **Inform RAN2 that 3-2/5/5a/5b should not be the part of prerequisite FGs of FG22-8a/8b/8c/8d, and ask RAN2 to update the prerequisite FGs of FG22-8a/8b/8c/8d e.g., by adopting one of following alternatives**
	+ **Alt.1: Update the prerequisite of FG22-8a/b/c/d to remove 3-2/5/5a/5b**
	+ **Alt.2: Introduce replicated FGs of FG22-8a/b/c/d with removing 3-2/5/5a/5b from prerequisite FGs, and dummify FG22-8a/b/c/d**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Informing RAN2 that 3-2/5/5a/5b should not be part of prerequisite of FG-22-8a seems sufficient. It is not necessary to list the two alternatives. |
| Huawei, HiSi | Support CATT. |
| Moderator (NTT DOCOMO) | Updated FL proposal 5 was agreed in GTW session as below. |

**Agreements:**

* **Components descriptions of FG22-8a/b/c/d are revised as in R1-2101249 to incorporate a copy of each of FG 3-2, 3-5, 3-5a, and 3-5b into each of FG 22-8a, 22-8b, 22-8c, and 22-8d, respectively**
* **Inform RAN2 that 3-2/5/5a/5b should not be the part of prerequisite FGs of FG22-8a/8b/8c/8d, and ask RAN2 to update FG22-8a/b/c/d according to above updated FGs in RAN1 UE features list**
	1. Licensed/unlicensed differentiation for Rel-15 features

Following proposals are made in contributions.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [5] | In previous RAN1 meeting [1], the following agreement was made for Rel-15 FGs differentiation between licensed and unlicensed bands. In this section, we share the views on FFS point for handling of FGs 4-19/4-23/4-28/5-17.

|  |
| --- |
| Agreements:* At least for the following FGs, Rel-16 FGs can be introduced to indicate the support of the feature in unlicensed band
	+ FG 1-2 (SS block based SINR measurement (SS-SINR))
	+ FG 2-32a/2-32b (Semi-persistent CSI report on PUCCH/PUSCH)
	+ FG 3-6 (Dynamic SFI monitoring)
	+ [FG 4-19]
	+ FG 4-19a/4-19b/4-19c/4-28 (HARQ-ACK multiplexing)
	+ FG 4-23 (Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8)
	+ FG 5-14/5-16/5-17/5-17a (PDSCH and PUSCH repetitions)
	+ [FG 5-18/5-19/5-20/5-21 (SPS and configured grant)]
* Note1: for above listed FGs, indicating the support of Rel-15 FG by Rel-16 UE means support of the feature in licensed band only
* Note2: for above listed FGs, Rel-16 FGs for unlicensed band replicated from Rel-15 are “optional with capability signaling” in UE features list
	+ FFS: whether each of Rel-16 versions of 4-19/4-23/4-28/5-17 is part of basic operation for corresponding scenarios of NR-U
* FFS: interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers
 |

FGs 4-19/4-23/4-28/5-17 were given as “Mandatory with capability signalling” in Rel-15, as follows.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4-19 | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same starting symbol on the PUCCH resources in a slot | SR/HARQ-ACK/CSI multiplexing once per slot, where overlapping PUCCH resources have the same starting symbols on the PUCCH resources in a slot while precluding the case of SR/HARQ-ACK by overlapping PUCCH resources with the same starting symbols on the PUCCH resources in a slot |  | *sameSymbol* in *mux-SR-HARQ-ACK-CSI-PUCCH-OncePerSlot* | *Phy-ParametersFRX-Diff* | No | Yes | If FG4-28 is not included or not supported, HARQ-ACK/CSI piggyback on PUSCH once per slot when the starting OFDM symbol of the PUSCH is the same as the starting OFDM symbols of the PUCCH resource(s) that would have been transmitted onIf FG4-28 is included and supported, HARQ-ACK/CSI piggyback on PUSCH once per slot for which case the starting OFDM symbol of the PUSCH is the different from the starting OFDM symbols of the PUCCH resource(s) that would have been transmitted on | Mandatory with capability signalling |
| 4-23 | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 |  | *pucch-Repetition-F1-3-4* | *Phy-ParametersCommon* | No | No |  | Mandatory with capability signalling |
| 4-28 | HARQ-ACK multiplexing on PUSCH with different PUCCH/PUSCH starting OFDM symbols | HARQ-ACK piggyback on a PUSCH with/without aperiodic CSI once per slot when the starting OFDM symbol of the PUSCH is different from the starting OFDM symbols of the PUCCH resource that HARQ-ACK would have been transmitted on | 4-1 | *mux-HARQ-ACK-PUSCH-DiffSymbol* | *Phy-ParametersFRX-Diff* | No | Yes |  | Mandatory with capability signalling |
| 5-17 | PUSCH repetitions over multiple slots | K = 2, 4, 8 times repetitions |  | *pusch-RepetitionMultiSlots* | *Phy-ParametersCommon* | No | No |  | Mandatory with capability signalling |

Therefore, it is preferable to apply them with basic FGs for NR-U. However, as discussed in RAN1#103-e, we need to further discuss on whether those FGs are defined as basic FGs for all or parts of the following scenarios (as in TS 38.300 Annex B.3).- Scenario A: Carrier aggregation between NR in licensed spectrum (PCell) and NR in shared spectrum (Scell);- Scenario A.1: Scell is not configured with uplink (DL only);- Scenario A.2: Scell is configured with uplink (DL+UL).- Scenario B: Dual connectivity between LTE in licensed spectrum and NR in shared spectrum (PSCell);- Scenario C: NR in shared spectrum (Pcell);- Scenario D: NR cell in shared spectrum and uplink in licensed spectrum;- Scenario E: Dual connectivity between NR in licensed spectrum (Pcell) and NR in shared spectrum (PSCell).Considering that FGs 4-19/4-23 are related to PUCCH operation, it seems reasonable to define them as basic FGs for scenarios B, C, D, and E. Similarly, considering that FGs 4-28/5-17 are related to PUSCH operation, it seems reasonable to define them as basic FGs for scenarios A2, B, C, D, and E.**Proposal:** Define FGs 4-19/4-23 as basic FGs for NR-U with scenarios B, C, D, and E as described in TS 38.300 Annex B.3.**Proposal:** Define FGs 4-28/5-17 as basic FGs for NR-U with scenarios A2, B, C, D, and E as described in TS 38.300 Annex B.3. |
| [9] | The following agreement was made at RAN1#103-e (yellow highlights have been added for open issues), for which details of the discussion are summarized in [1]:Agreements:* At least for the following FGs, Rel-16 FGs can be introduced to indicate the support of the feature in unlicensed band
	+ FG 1-2 (SS block based SINR measurement (SS-SINR))
	+ FG 2-32a/2-32b (Semi-persistent CSI report on PUCCH/PUSCH)
	+ FG 3-6 (Dynamic SFI monitoring)
	+ [FG 4-19]
	+ FG 4-19a/4-19b/4-19c/4-28 (HARQ-ACK multiplexing)
	+ FG 4-23 (Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8)
	+ FG 5-14/5-16/5-17/5-17a (PDSCH and PUSCH repetitions)
	+ [FG 5-18/5-19/5-20/5-21 (SPS and configured grant)]
* Note1: for above listed FGs, indicating the support of Rel-15 FG by Rel-16 UE means support of the feature in licensed band only
* Note2: for above listed FGs, Rel-16 FGs for unlicensed band replicated from Rel-15 are “optional with capability signaling” in UE features list
	+ FFS: whether each of Rel-16 versions of 4-19/4-23/4-28/5-17 is part of basic operation for corresponding scenarios of NR-U
* FFS: interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers

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| Index | Feature group | Component | Mandatory/Optional |
| 4-19 | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same starting symbol on the PUCCH resources in a slot | SR/HARQ-ACK/CSI multiplexing once per slot, where overlapping PUCCH resources have the same starting symbols on the PUCCH resources in a slot while precluding the case of SR/HARQ-ACK by overlapping PUCCH resources with the same starting symbols on the PUCCH resources in a slot | Mandatory with capability signaling |
| 5-18 | DL SPS |  | Optional with capability signaling |
| 5-19 | Type 1 Configured UL grant | 1) K = 1 | Optional with capability signaling |
| 5-20 | Type 2 Configured UL grant  | 1) K = 1 | Optional with capability signaling |
| 5-21 | Pre-emption indication for DL |  | Optional with capability signaling |

The reason from the original proposal in [2] was summarized by Qualcomm:*The issue is that unless the base station(s) implement the features both in licensed and unlicensed, the feature cannot be tested. Then it cannot be deployed either in licensed or in unlicensed for a UE that has both licensed and unlicensed capability.*The assumption for this statement was that there could be unexpected implementation differences for the same feature for a licensed or unlicensed band, although from a functionality perspective no difference is foreseen (in particular no difference related to LBT).Several companies have indicated there is no need for differentiation for Rel-15 optional FGs 5-18, 5-19, 5-20 and 5-21, in the sense that it is not expected that there would be any need for a different UE implementation of these features for licensed or unlicensed operation. However, this was also true for some of the other FGs already agreed for differentiation, e.g. FGs 4-19a/4-19b/4-19c for which the following conclusion made in RAN1#102e justified no need for differentiation:*For operation with shared spectrum channel access, it is a common understanding that when UE performs UCI multiplexing on PUSCH or PUCCH, that the multiplexing procedure is not dependent on the outcome of the channel access procedure corresponding to the PUSCH or PUCCH transmission.*For consistency, even though this may unnecessarily increase capability signaling overhead, we could accept to also introduce Rel-16 capabilities for unlicensed operation for FGs 5-18, 5-19, 5-20 and 5-21.**Proposal 1: Introduce Rel-16 FGs to indicate support of the features in unlicensed band for FGs 5-18, 5-19, 5-20 and 5-21.**Among the FGs agreed for Rel-16 differentiation for unlicensed operation, FGs 4-23, 4-28 and 5-17 are mandatory with capability signaling in Rel-15. FG 4-19 is still under discussion and is also mandatory with capability signaling in Rel-15.

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| 4-23 | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 |  |
| 4-28 | HARQ-ACK multiplexing on PUSCH with different PUCCH/PUSCH starting OFDM symbols | HARQ-ACK piggyback on a PUSCH with/without aperiodic CSI once per slot when the starting OFDM symbol of the PUSCH is different from the starting OFDM symbols of the PUCCH resource that HARQ-ACK would have been transmitted on |
| 5-17 | PUSCH repetitions over multiple slots  | 1) K = 2, 4, 8 times repetitions |

Qualcomm explained that for those FGs (including 4-19) the intent is not to make the feature optional but to signal the IODT bit separately for licensed and unlicensed operation. Apple’s understanding is that there is no baseline and that a new decision is needed for the newly introduced Rel-16 signaling, and this discussion amounts to discussing whether the new Rel-16 capabilities are basic FGs for NR-U scenarios.LG Electronics proposed that FG4-19 should be a basic feature group for NR-U scenarios supporting PUCCH in unlicensed spectrum. MediaTek proposed that mandatory or optional for Rel-15 FG is not changed, but Rel-16 FG for unlicensed band is optional with capability signalling except for FG4-19, which should be mandatory with capability signalling for NR-U deployment scenarios B, C and E specified in Annex B.3 of TS38.300.As per note 2 in the agreement, it is only needed to discuss whether each of Rel-16 versions of 4-19/4-23/4-28/5-17 is part of basic operation for corresponding scenarios of NR-U.FG4-19 corresponds to the per-UE capability *mux-SR-HARQ-ACK-CSI-PUCCH-OncePerSlot* wheremultiplexing and piggybacking features is indicated by *sameSymbol*.In our view, if unlicensed differentiation is introduced for FG4-19, then FG4-19 should be a basic FG for scenarios A.2, B, C and E. For scenarios A.1 and D where uplink is in licensed spectrum, the Rel-15 capability of FG4-19 remains mandatory.There is no direct signaling from a UE about supported NR-U scenarios, but the UE can signal that it supports only unlicensed bands or both licensed and unlicensed bands (in band combinations), and the UE can signal some or all of the NR-U basic FGs.* Case 1: UE capability report includes only unlicensed bands. UE reports basic FGs only for NR-U scenarios with uplink in unlicensed band. UE reports FG4-19.
* Case 2: UE capability report includes band combinations with both licensed and unlicensed bands. UE reports basic FGs only for NR-U scenarios with uplink in licensed band. UE reports FG4-19.
* Case 3: UE capability report includes band combinations with both licensed and unlicensed bands. UE reports basic FGs only for NR-U scenarios with uplink in unlicensed band. UE reports FG4-19.
* Case 4: UE capability report includes band combinations with both licensed and unlicensed bands. UE reports basic FGs for all NR-U scenarios. UE reports FG4-19.

Based on the UE report of the supported bands/band combinations and NR-U basic FGs, the gNB can infer whether the UE supports NR-U operation with uplink in licensed, unlicensed or both licensed and unlicensed bands. Therefore, the gNB can assume whether FG4-19 has been tested with uplink in licensed, unlicensed, or both licensed and unlicensed operation. This should be unambiguous for cases 1, 2 and 3.In case 4, some ambiguity could exist since there is no association between the capability signaling of basic NR-U FGs and the supported band combinations. In other words, for a given band combination including a licensed band and an unlicensed band, if the UE reports basic FGs for NR-U scenarios where uplink could be in licensed or unlicensed band, then the gNB should assume that both NR-U scenarios are supported for the same band combination. But if we assume that the UE may not have been tested with uplink in licensed band (for example) for the relevant NR-U scenarios because no gNB was available for such testing, then there is no way for the UE to indicate this. The only alternative is that UE does not report any band combination including both licensed and unlicensed band, in which case the UE cannot report that it supports the case that it was tested for (in this case uplink in unlicensed band).Based on this, it would be useful to introduce licensed/unlicensed differentiation for FG4-19 with a Rel-16 UE capability for FG4-19 where PUSCH/PUCCH is in unlicensed band, if we assume that it may not be possible to find gNBs for testing UE with PUSCH/PUCCH in both licensed and unlicensed bands.**Proposal 2: Introduce a Rel-16 FG to indicate support of the feature in unlicensed band for FG4-19.**Likewise, the unlicensed version of the capabilities corresponding to FGs 4-23, 4-28 and 5-17 should be basic FGs for NR-U scenarios with uplink in unlicensed band, i.e. scenarios A.2, B, C and E.**Proposal 3: The Rel-16 FGs for unlicensed operation related to FG4-19, 4-23, 4-28 and 5-17 are basic FGs for NR-U scenarios A.2, B, C and E.**Regarding the interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carrier, one example question is *“if the uplink is in licensed band in relation to DL in unlicensed band, should the UE signal the Rel-15 capability (for licensed operation) or the new Rel-16 capability (for unlicensed operation) corresponding to a specific uplink capability (such as FG4-19)?”*.In the above discussion, we have assumed that the UE should report the Rel-15 capability in the case above, which could occur for example in scenario A.1 where NR-U Scell is not configured with uplink (DL only).**Proposal 4: the newly introduced Rel-16 FGs (that correspond to unlicensed operation of Rel-15 FGs) indicate support of the feature on a carrier configured in unlicensed band.*** **For indicating the support of a feature on a carrier configured in licensed band in a band combination including an unlicensed band, the Rel-15 capability should be reported.**
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| [13] | At the RAN1#103-e meeting, following agreements regarding licensed/unlicensed differentiation for Rel-15 features were made [3]. There are some brackets and FFS points in the agreements and hense those issues should be solved in this meeting.

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| **Agreements:*** **At least for the following FGs, Rel-16 FGs can be introduced to indicate the support of the feature in unlicensed band**
	+ **FG 1-2 (SS block based SINR measurement (SS-SINR))**
	+ **FG 2-32a/2-32b (Semi-persistent CSI report on PUCCH/PUSCH)**
	+ **FG 3-6 (Dynamic SFI monitoring)**
	+ **[FG 4-19]**
	+ **FG 4-19a/4-19b/4-19c/4-28 (HARQ-ACK multiplexing)**
	+ **FG 4-23 (Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8)**
	+ **FG 5-14/5-16/5-17/5-17a (PDSCH and PUSCH repetitions)**
	+ **[FG 5-18/5-19/5-20/5-21 (SPS and configured grant)]**
* **Note1: for above listed FGs, indicating the support of Rel-15 FG by Rel-16 UE means support of the feature in licensed band only**
* **Note2: for above listed FGs, Rel-16 FGs for unlicensed band replicated from Rel-15 are “optional with capability signaling” in UE features list**
	+ **FFS: whether each of Rel-16 versions of 4-19/4-23/4-28/5-17 is part of basic operation for corresponding scenarios of NR-U**
* **FFS: interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers**
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View* [FG 4-19]: No differentiation is necessary due to the conclusion made in RAN1#102e*Conclusion:For operation with shared spectrum channel access, it is a common understanding that when UE performs UCI multiplexing on PUSCH or PUCCH, that the multiplexing procedure is not dependent on the outcome of the channel access procedure corresponding to the PUSCH or PUCCH transmission.*
* [FG 5-18/5-19/5-20/5-21 (SPS and configured grant)]: As the features themselves have the same UE behavior between licensed/unlicensed bands other than LBT, we think no differentiation is necessary. By the way, FG 5-21 is nothing with SPS or CG as it is the FG for Pre-emption indication for DL, which should not be included in the same bullet.
* FFS: whether each of Rel-16 versions of 4-19/4-23/4-28/5-17 is part of basic operation for corresponding scenarios of NR-U in Note2:
	+ FG4-19: As no differentiation is necessary as mentioned above, no further discussion is necessary.
	+ FG4-23/4-28/5-17: We don’t see the motivation to be part of basic operation for NR-U
* FFS: interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers:
	+ FG 3-6 (Dynamic SFI monitoring): This feature includes 1) SFI monitoring on the indicating band 2) Adjust periodic and semi-persistent signal reception and transmission on the indicated band and hence, interpretation 3 would be appropriate one.

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| 22. NR Others | 22-10(1-2) | SS block based SINR measurement (SS-SINR) for unlicensed spectrum | SS-SINR measurement for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-11(2-32a) | Semi-persistent CSI report on PUCCH for unlicensed spectrum | 1) Support report on PUCCH formats over 1 – 2 OFDM symbols once per slot (or piggybacked on a PUSCH) for unlicensed spectrum2) Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot (or piggybacked on a PUSCH) for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-11a(2-32b) | Semi-persistent CSI report on PUSCH for unlicensed spectrum | Support semi-persistent CSI report on PUSCH for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-12 (3-6) | Dynamic SFI monitoring for unlicensed spectrum | Adjust periodic and semi-persistent signal reception and transmission in response to detected dynamic UL/DL configuration for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | [22-13 (4-19)] | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same starting symbol on the PUCCH resources in a slot for unlicensed spectrum | SR/HARQ-ACK/CSI multiplexing once per slot, where overlapping PUCCH resources have the same starting symbols on the PUCCH resources in a slot while precluding the case of SR/HARQ-ACK by overlapping PUCCH resources with the same starting symbols on the PUCCH resources in a slot for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-13a (4-19a) | SR/HARQ-ACK multiplexing once per slot using a PUCCH (or HARQ-ACK piggybacked on a PUSCH) when SR/HARQ-ACK are supposed to be sent with different starting symbols in a slot for unlicensed spectrum | Overlapping PUCCH resources have different starting symbols in a slot for unlicensed spectrum | [22-13] | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13b (4-19b) | SR/HARQ-ACK/CSI multiplexing more than once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same or different starting symbol in a slot for unlicensed spectrum | Overlapping PUCCH resources have same or different starting symbols in a slot for unlicensed spectrum | 22-13c | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13c (4-19c) | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with different starting symbols in a slot for unlicensed spectrum | Overlapping PUCCH resources have different starting symbols in a slot for unlicensed spectrum | 22-13a | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-14 (4-28) | HARQ-ACK multiplexing on PUSCH with different PUCCH/PUSCH starting OFDM symbols for unlicensed spectrum | HARQ-ACK piggyback on a PUSCH with/without aperiodic CSI once per slot when the starting OFDM symbol of the PUSCH is different from the starting OFDM symbols of the PUCCH resource that HARQ-ACK would have been transmitted on for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-15 (4-23) | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 for unlicensed spectrum | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-16 (5-14) | Type 1 configured PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions with RV sequences for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-17 (5-16) | Type 2 configured PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions with RV sequences for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-18 (5-17) | PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-18a (5-17a) | PDSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | [22-19 (5-18)] | DL SPS for unlicensed spectrum | DL SPS for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | [22-20 (5-19)] | Type 1 Configured UL grant for unlicensed spectrum | K = 1 for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | [22-21 (5-20)] | Type 2 Configured UL grant for unlicensed spectrum | K = 1 for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | [22-22 (5-21)] | Pre-emption indication for DL for unlicensed spectrum | Pre-emption indication for DL for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |

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Based on the above proposals, following point can be discussed in RAN1#104-e meeting.

**Discussion point #4**

* **Regarding licensed/unlicensed differentiation for Rel-15 FGs**
	+ **Confirm the FG descriptions of new FGs to indicate the support of following FG in unlicensed band (as agreed in RAN1#103-e)**
		- **FG 1-2 (SS block based SINR measurement (SS-SINR))**
		- **FG 2-32a/2-32b (Semi-persistent CSI report on PUCCH/PUSCH)**
		- **FG 3-6 (Dynamic SFI monitoring)**
		- **FG 4-19a/4-19b/4-19c/4-28 (HARQ-ACK multiplexing)**
		- **FG 4-23 (Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8)**
		- **FG 5-14/5-16/5-17/5-17a (PDSCH and PUSCH repetitions)**
	+ **Whether or not to add new FG(s) to indicate the support of following FG in unlicensed band**
		- **[FG 4-19]**
		- **[FG 5-18/5-19/5-20/5-21 (SPS and configured grant)]**
	+ **Whether each of Rel-16 versions of 4-19/4-23/4-28/5-17 is part of basic operation for corresponding scenarios of NR-U**
	+ **Whether/how to clarify the interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers**

Companies’ views in the contributions can be summarized as below.

* **Confirm the FG descriptions of new FGs to indicate the support of following FG in unlicensed band (as agreed in RAN1#103-e)**
	+ **Support: DOCOMO**
* **Add new FGs to indicate the support of following FG in unlicensed band Support**
	+ **FG 4-19**
		- **Support: Huawei/HiSi**
		- **Not support: DOCOMO**
	+ **FG 5-18/5-19/5-20/5-21 (SPS and configured grant)**
		- **Support: Huawei/HiSi**
		- **Not support: DOCOMO**
* **Define FGs 4-19/4-23 as basic FGs for NR-U**
	+ **with scenarios B, C, D, and E: LG**
	+ **with scenarios A2, B, C, and E: Huawei/HiSi**
	+ **Not support: DOCOMO**
* **Define FGs 4-28/5-17 as basic FGs for NR-U**
	+ **with scenarios A2, B, C, D, and E: LG**
	+ **with scenarios A2, B, C, and E: Huawei/HiSi**
	+ **Not support: DOCOMO**
* **Regarding the interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers**
	+ **The newly introduced Rel-16 FGs (that correspond to unlicensed operation of Rel-15 FGs) indicate support of the feature on a carrier configured in unlicensed band. For indicating the support of a feature on a carrier configured in licensed band in a band combination including an unlicensed band, the Rel-15 capability should be reported.**
		- **Support: Huawei/HiSi**
	+ **Interpretation 3 is applied to FG3-6**
		- **Support: DOCOMO**

Based on above, following FL proposals can be made.

**FL proposal 6:**

* **Confirm the FG descriptions of new FGs to indicate the support of following FG in unlicensed band (as agreed in RAN1#103-e)**

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| 22. NR Others | 22-10(1-2) | SS block based SINR measurement (SS-SINR) for unlicensed spectrum | SS-SINR measurement for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-11(2-32a) | Semi-persistent CSI report on PUCCH for unlicensed spectrum | 1) Support report on PUCCH formats over 1 – 2 OFDM symbols once per slot (or piggybacked on a PUSCH) for unlicensed spectrum2) Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot (or piggybacked on a PUSCH) for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-11a(2-32b) | Semi-persistent CSI report on PUSCH for unlicensed spectrum | Support semi-persistent CSI report on PUSCH for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-12 (3-6) | Dynamic SFI monitoring for unlicensed spectrum | Adjust periodic and semi-persistent signal reception and transmission in response to detected dynamic UL/DL configuration for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13a (4-19a) | SR/HARQ-ACK multiplexing once per slot using a PUCCH (or HARQ-ACK piggybacked on a PUSCH) when SR/HARQ-ACK are supposed to be sent with different starting symbols in a slot for unlicensed spectrum | Overlapping PUCCH resources have different starting symbols in a slot for unlicensed spectrum | [22-13] | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13b (4-19b) | SR/HARQ-ACK/CSI multiplexing more than once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same or different starting symbol in a slot for unlicensed spectrum | Overlapping PUCCH resources have same or different starting symbols in a slot for unlicensed spectrum | 22-13c | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13c (4-19c) | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with different starting symbols in a slot for unlicensed spectrum | Overlapping PUCCH resources have different starting symbols in a slot for unlicensed spectrum | 22-13a | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-14 (4-28) | HARQ-ACK multiplexing on PUSCH with different PUCCH/PUSCH starting OFDM symbols for unlicensed spectrum | HARQ-ACK piggyback on a PUSCH with/without aperiodic CSI once per slot when the starting OFDM symbol of the PUSCH is different from the starting OFDM symbols of the PUCCH resource that HARQ-ACK would have been transmitted on for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-15 (4-23) | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 for unlicensed spectrum | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-16 (5-14) | Type 1 configured PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions with RV sequences for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-17 (5-16) | Type 2 configured PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions with RV sequences for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-18 (5-17) | PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-18a (5-17a) | PDSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | We agree with the proposal |
| Nokia, NSB | We agree with the FL proposal |
| Ericsson | Support the FL proposal |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, FL proposal 6 seems acceptable.So, let’s try to make it agreement in GTW session on Tuesday. |
| ZTE | Support the FL proposal |
| LG Electronics | Support the FL proposal. |
| Huawei, HiSilicon | Support the FL proposal. |
| Moderator (NTT DOCOMO) | FL proposal 6 was agreed in GTW session. |

**FL proposal 7:**

* **Adopt one of following alternatives**
	+ **Alt.1: add new FGs to indicate the support of each of FG 4-19/5-18/5-19/5-20/5-21 in unlicensed band**
	+ **Alt.2: do not add new FGs to indicate the support of each of FG 4-19/5-18/5-19/5-20/5-21 in unlicensed band**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | We support Alt 2 because of the following reasons[FG 4-19]: No differentiation is necessary due to the conclusion made in RAN1#102eConclusion:*For operation with shared spectrum channel access, it is a common understanding that when UE performs UCI multiplexing on PUSCH or PUCCH, that the multiplexing procedure is not dependent on the outcome of the channel access procedure corresponding to the PUSCH or PUCCH transmission.*[FG 5-18/5-19/5-20/5-21 (SPS and configured grant)]: As the features themselves have the same UE behavior between licensed/unlicensed bands other than LBT, we think no differentiation is necessary. By the way, FG 5-21 is nothing with SPS or CG as it is the FG for Pre-emption indication for DL, which should not be included in the same bullet. |
| Samsung | We prefer alt2 since we do not see strong motivation for licensed/unlicensed differentiation. |
| Ericsson | Before stating whether we prefer Alt 1 and Alt 2, we would like ot mention that we have found the direction that the discussion is going a bit confusing. When importing Rel-15 FG to Rel-16 was discussed, the motivation that made sense to us, was to separate a FG for licensed and unlicensed, enables to have a different testing for lic and unlic.However, as the discussion progressed, it became complicated for Rel-15 mandatory features, claiming that support of operation on unlicensed in optional by itself, hence claiming no feature can be mandatory. The outcome, as in the WG, became that imported Rel-15 Fg to Rel-16, to be optional.The issue we have is that “when a device operates in unlicensed”, the mandatory FG in Rel-15, specially 4-19 should be also supported. Otherwise, the operation on unlicensed is quite compromised. Focusing on facilitating different IODt for licensed and unlicensed, we are in prociple are fine to have the lic/unlic differentiation, but as explained above, we don’t think it is reasonable the FG to be optional. Therefore, back to Alt1 and Alt2:Alt 1 may lead that FG 4-9 to have the same faith as FG in WA and end up being optional. Therefore, we are hesitant to support it and we see Alt 2 is safer. If Alt 1 ensures for operation on unlic, Re-16 4-9 would be mandatory, we are fine. But so far, we don’t think that is feasible. **Hence, the best option we can support now is Alt 2 for 4-9. For other FGs 5-18/5-19/5-20/5-21 targetting repetiton, we are fine with Alt 1, and perhaps even if they end up being optional.** **Hence, we support Alt 2,** and explained the conditions that if considered, we can adjust our position. |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, Alt.2 can be possible conclusion.But further inputs from other companies may be helpful. |
| ZTE | Alt.1 is preferred |
| Huawei, HiSilicon | We support Alt. 1 to address if there is sustained IoDT concern. However we are surely also Ok with Alt. 2, since we also indicated that there is no implmenetation difference from UE perspective in previous discussion and less signalling would also be benefical to networks. |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks and discussion in GTW session.Based on the discussion in GTW session, FL proposal 7 and 8 can be combined and discussed together. |

**Updated FL proposal 7 & 8:**

* **Add new FGs to indicate the support of each of FG 4-19/5-18/5-19/5-20/5-21 in unlicensed band**
* **define new FGs based on 4-19/4-23 as basic FGs for NR-U with scenarios [A2,] B, C, [D] and E**
* **define FGs 4-28/5-17 as basic FGs for NR-U with scenarios [A2,] B, C, [D] and E**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| LG Electronics | Support the first bullet.On the scenarios,* Scenario A2 can be added considering PUCCH-SCell as Ericsson commented in the last GTW session.
* It would be safer to include scenario D as well since one of interpretations for scenario D corresponds to (DL+UL) unlicensed carrier + SUL licensed carrier for which unlicensed UL still exists.
* For 4-23 (PUCCH repetition), we slightly prefer to make it basic FG. When some of repeated PUCCHs can be failed for LBT due to gap between PUCCHs, UE can simply drop LBT-failed PUCCH. If gNB wants to avoid this situation, gNB can configure PUCCH occupying the whole slot.

Therefore, we would suggest the following:* **Add new FGs to indicate the support of each of FG 4-19/5-18/5-19/5-20/5-21 in unlicensed band**
* **Define new FGs based on 4-19/4-23/4-28/5-17 as basic FGs for NR-U with scenarios ~~[~~A2,~~]~~ B, C, ~~[~~D~~]~~ and E**
 |
| DOCOMO | Regarding [4-19], we can live with addig new FG if majority companies support that as the new FG is not necessary for the deployment scenarios where UL is on licensed band. The new FG is basic FG for NR-U with scenarios B, C, and E as PUCCH is transmitted on licensed PCell/PSCellRegarding [5-18/5-19/5-20/5-21], we can live with adding new FGs if majority companies support that to address IoDT concern.Regarding 4-23, the new FG is basic FG for NR-U with scenarios B, C, and E, where PUCCH is transmitted on unlicensed bandRegarding 4-28/5-17, the new FGs are basic FGs for NR-U with scenarios A2, B, C, and E, where PUSCH is transmitted on unlicensed band |
| Nokia, NSB | We are in general fine with the FL proposals, but we agree with LG that scenario D needs to be included in the list of scenarios where the features are basic. The definition of scenario D is: * Scenario D: NR cell in shared spectrum and uplink in licensed spectrum;

“NR cell” can include both downlink and uplink, and hence a UE designed to support such scenario needs to support UL in unlicensed bands as well. |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks, we can check if LG’s update for the proposal is acceptable to all. |

### **Updated FL proposal 7 & 8:**

* **Add new FGs to indicate the support of each of FG 4-19/5-18/5-19/5-20/5-21 in unlicensed band**
* **define new FGs based on 4-19/4-23/4-28/5-17 as basic FGs for NR-U with scenarios A2, B, C, D and E**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| Apple | We can align with the current UE NRU feature list by “basic FGs” -> “basic operation” We propose to remove FG4-23/FG5-17 from the basic operation. FG4-23 (PUCCH repetition) and FG5-17 (PUSCH repetition) is very likely to leave gap between adjacent PUCCH/PUSCH repetition in different slots, which may complicate the CCA procedure. It may not be that essential to the NRU UL opereation. Or at least, we can have a discussion on this. |
| DOCOMO | We are fine with 1st bullet.Regarding 2nd bullet, we don’t think PUCCH-SCell is basic operation in scenario A2 and hence, 4-19/4-23 should not be the basic FGs for scenario A2. |
| Huawei, HiSilicon | We are fine with the updated proposal, but would also prefer not to overload the NR-U scenarios with basic FGs unless we are certain that a FG is necessary for basic operation in a scenario. Therefore, from the comments of Apple and Docomo, we can have a sub-bullet per new FGs and list the scenarios for which this new FG is a basic FG.* **Add new FGs to indicate the support of each of FG 4-19/5-18/5-19/5-20/5-21 in unlicensed band**
* **The new FGs based on 4-19 and 4-28 are defined as basic FGs for NR-U**
	+ **4-19 is basic FGs for NR-U with scenarios B, C, D and E**
	+ **4-28 is basic FGs for NR-U with scenarios A2, B, C, D and E**
 |

**FL proposal 8:**

* **Regarding [4-19] and 4-23, adopt one of following alternatives**
	+ **Alt.1: define FGs [4-19/]4-23 as basic FGs for NR-U with scenarios B, C, D, and E**
	+ **Alt.2: define FGs [4-19/]4-23 as basic FGs for NR-U with scenarios A2, B, C, and E**
	+ **Alt.3: do not define FGs [4-19/]4-23 as basic FGs for NR-U**
* **Regarding 4-28 and 5-17, adopt one of following alternatives**
	+ **Alt.1: define FGs 4-28/5-17 as basic FGs for NR-U with scenarios A2, B, C, D, and E**
	+ **Alt.2: define FGs 4-28/5-17 as basic FGs for NR-U with scenarios A2, B, C, and E**
	+ **Alt.3: do not define FGs 4-28/5-17 as basic FGs for NR-U**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | Regarding [4-19], as mentioned in FL proposal 7, we don’t see the necessity of differentiation and hence, it is mandatory with capability signalling irrespective of licensed/unlicensed bands.Regarding 4-23/4-28/5-17, we misunderstood the discussion point when submitting contribution. As they are mandatory with capability signaling in Rel-15, they should be basic FGs for applicable scenarios. As they are the features for PUSCH/PUCCH, the applicable scenarios are A2, B, C, and E (i.e. Alt 2). |
| Nokia, NSB | It is OK to define those FGs corresponding to FGs that are mandatory with capability in licensed as basic for the relevant scenarios.  |
| Samsung | We support them as basic FGs. |
| Ericsson | Regarding [4-19] and 4-23:* Is it correct understanding that by having these FGs as basic FGs in NR-U, it measn that for a relevant scenario, the Fg would be mandatory? If yes, as we explained in PRoosal 7, we prefer Alt 3 but we can accept Alt 2. If no, we support Alt 3 for the reasons explained.
* Note that we think [4-19] is more critical than 4-23.
* By the way, could you please clarify/remind us why [4-19] is in []?

Regarding 4-28 and 5-17:* As we explaine for proposal 7, our first preference is Alt 3, but we are OK with Alt 1, too. We don’t think repetition is critical.
 |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, it seems that companies may be fine to define 4-23/4-28/5-17 as part of basic FGs for applicable scenarios.([4-19] is still under the discussion on whether licensed/unlicensed differentiation is necessary or not as in FL proposal 7, and hence it is within [].)So, we can further discuss applicable scenarios i.e., Alt.1 or Alt.2.Further inputs are helpful. |
| ZTE | Alt. 2 is preferred |
| LG Electronics | Regarding 4-28 and 5-17, we support Alt.2, but for FG 4-23, since FG 4-23 is for PUCCH repetition, FG 4-23 does not require basic FG for scenario A2 (DL+UL for LAA deployment). |
| Huawei | We support Alt. 2 as the propoents while if it can be agreed that no differentiation is needed for 4-19 it is also OK for us to remove 4-19 from the proposals. |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks and discussion in GTW session.Based on the discussion in GTW session, FL proposal 7 and 8 can be combined and discussed together. |

### **FL proposal 9:**

* **Regarding the interpretation of support of FG in case of cross-carrier operation between licensed and unlicensed carriers**
	+ **The newly introduced Rel-16 FGs (that correspond to unlicensed operation of Rel-15 FGs) indicate support of the feature on a carrier configured in unlicensed band. For indicating the support of a feature on a carrier configured in licensed band in a band combination including an unlicensed band, the Rel-15 capability should be reported.**
	+ **Interpretation 3 is applied to FG3-6**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposal:

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | In our understanding, FG in case of cross-carrier operation include two parts; 1) scheduling/triggering/indicating on a licensed/unlicensed cell, 2) scheduled/triggered/indicated UE behavior on an unlicensed/licensed cell. Threfore, we think the interepreration should be discussed FG-by-FG similar to other discussion on cross-carrier operation. In that sence, we think interpretation 1 should be applied to almost all agreed FGs, except for FG 3-6, where interpretation 3 should be applied as this FG includes 1) SFI monitoring on the indicating cell, and 2) adjust periodic and semi-persistent signal reception and transmission on the indicated cell. |
| Samsung | We support interpretation 3 for FG3-6. |
| Ericsson | FL proposal can be acceptable to us.  |
| Moderator (NTT DOCOMO) | Thanks for the feedbacks.Based on the feedbacks so far, it seems that interpretation 3 can be applied to FG3-6.Further inputs are helpful especially for other FGs. |
| ZTE | Ok with the proposal. But it may be safer to discuss this issue in a case-by-case manner.  |
| Huawei | Support the proposal and propose to attach the definition of Interpreation 3 to form a complete conclusion, i.e. adding a note *Interpretation 3: Regarding the interpretation of UE capabilities in case of cross-carrier operation, RAN1 clarifies that support of the following UE capability is based on both the support of this capability for the band of the scheduled/triggered/indicated cell and the support of this capability for the band of the scheduling/triggering/indicating cell.* |
|  |  |

1. Conclusion

**Agreements:**

* **Components descriptions of FG22-8a/b/c/d are revised as in R1-2101249 to incorporate a copy of each of FG 3-2, 3-5, 3-5a, and 3-5b into each of FG 22-8a, 22-8b, 22-8c, and 22-8d, respectively**
* **Inform RAN2 that 3-2/5/5a/5b should not be the part of prerequisite FGs of FG22-8a/8b/8c/8d, and ask RAN2 to update FG22-8a/b/c/d according to above updated FGs in RAN1 UE features list**

**Agreements:**

* **Confirm the FG descriptions of new FGs to indicate the support of following FG in unlicensed band (as agreed in RAN1#103-e)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 22. NR Others | 22-10(1-2) | SS block based SINR measurement (SS-SINR) for unlicensed spectrum | SS-SINR measurement for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-11(2-32a) | Semi-persistent CSI report on PUCCH for unlicensed spectrum | 1) Support report on PUCCH formats over 1 – 2 OFDM symbols once per slot (or piggybacked on a PUSCH) for unlicensed spectrum2) Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot (or piggybacked on a PUSCH) for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-11a(2-32b) | Semi-persistent CSI report on PUSCH for unlicensed spectrum | Support semi-persistent CSI report on PUSCH for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-12 (3-6) | Dynamic SFI monitoring for unlicensed spectrum | Adjust periodic and semi-persistent signal reception and transmission in response to detected dynamic UL/DL configuration for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13a (4-19a) | SR/HARQ-ACK multiplexing once per slot using a PUCCH (or HARQ-ACK piggybacked on a PUSCH) when SR/HARQ-ACK are supposed to be sent with different starting symbols in a slot for unlicensed spectrum | Overlapping PUCCH resources have different starting symbols in a slot for unlicensed spectrum | [22-13] | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13b (4-19b) | SR/HARQ-ACK/CSI multiplexing more than once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same or different starting symbol in a slot for unlicensed spectrum | Overlapping PUCCH resources have same or different starting symbols in a slot for unlicensed spectrum | 22-13c | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-13c (4-19c) | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or HARQ-ACK/CSI piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with different starting symbols in a slot for unlicensed spectrum | Overlapping PUCCH resources have different starting symbols in a slot for unlicensed spectrum | 22-13a | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-14 (4-28) | HARQ-ACK multiplexing on PUSCH with different PUCCH/PUSCH starting OFDM symbols for unlicensed spectrum | HARQ-ACK piggyback on a PUSCH with/without aperiodic CSI once per slot when the starting OFDM symbol of the PUSCH is different from the starting OFDM symbols of the PUCCH resource that HARQ-ACK would have been transmitted on for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-15 (4-23) | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 for unlicensed spectrum | Repetitions for PUCCH format 1, 3, and 4 over multiple slots with K = 2, 4, 8 for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-16 (5-14) | Type 1 configured PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions with RV sequences for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-17 (5-16) | Type 2 configured PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions with RV sequences for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-18 (5-17) | PUSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling[This FG may be a part of basic operation for a particular NR-U scenario]  |
| 22. NR Others | 22-18a (5-17a) | PDSCH repetitions over multiple slots for unlicensed spectrum | K = 2, 4, 8 times repetitions for unlicensed spectrum |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |

Reference

[1] R1-2009585 Updated RAN1 UE features list for Rel-16 NR Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2100094 Discussion on NR Rel-16 UE Features ZTE

[3] R1-2100140 Correction for V2X UE feature list OPPO

[4] R1-2100522 Remaining details of Rel-16 NR UE features Ericsson

[5] R1-2100554 Discussion on NR Rel-16 UE features LG Electronics

[6] R1-2100635 Remaining issue on UE features Intel Corporation

[7] R1-2101184 On NR Rel.16 UE features Samsung

[8] R1-2101249 Updates on NR UE Features Nokia, Nokia Shanghai Bell

[9] R1-2101273 Remaining details of Rel-16 NR UE features Huawei, HiSilicon

[10] R1-2101342 Discussions on NR Rel-16 UE features Apple

[11] R1-2101444 Discussion on NR Rel-16 UE features Qualcomm Incorporated

[12] R1-2101517 Correction on half-DuplexTDD-CA-SameSCS-r16 CATT

[13] R1-2101587 Remaining issues on Rel-16 NR UE features NTT DOCOMO, INC.

[14] R1-2101685 Remaining issues on Rel-16 eMIMO UE features vivo

[15] R1-2101737 Discussion on UE capability xDD differentiation for SUL/SDL bands Huawei, HiSilicon

Appendix: NR UE features list for others in [1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 22. NR Others | 22-1 | Indicating supported option for UL Tx switching for inter-band UL CA | Indicating supported option for UL Tx switching for inter-band UL CA* Candidate values set is {option1, option2, both option 1 and option 2}
 | 6-6 and RAN4 FG 7-1 (Tx switching period between two uplink carriers) | Yes | N/A |  | Per BC | N/A | N/A (FR1 only) | N/A | It has been agreed in RAN1 that UE can report support of one of the three candidates {option1, option2, both option1 and option2}. It is up to RAN2 to design the corresponding UE capability signalling. | Signaling of this FG is mandatory conditioned on the support of switching time capability for Tx switching between two uplink carriers in inter-band UL CA band combinations in RAN4 FG 7-1 (i.e. Tx switching period between two uplink carriers) |
| 22. NR Others | 22-2 | Indicating supported option for UL Tx switching for EN-DC | Indicating supported option for UL Tx switching for EN-DC* Candidate values set is {option1, option2}
 | EN-DC and RAN4 FG 7-1 (Tx switching period between two uplink carriers) | Yes | N/A |  | Per BC | N/A | N/A (FR1 only) | N/A |  | Signaling of this FG is mandatory conditioned on the support of switching time capability for Tx switching between two uplink carriers in EN-DC in RAN4 FG 7-1 (i.e. Tx switching period between two uplink carriers) |
| 22. NR Others | 22-3a | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 2 | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3b | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3c | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3d | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3e | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 2 | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3f | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3g | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3h | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4a | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 1 | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4b | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4c | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4d | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4e | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 1 | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4f | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4g | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4h | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-5a | Simultaneous transmission of SRS for antenna switching and SRS for CB/NCB /BM for intra-band UL CA | 1.     Support transmission of SRS for xTyR (x<y) based antenna switching and SRS for CB/NCB /BM on different CCs in overlapped symbol(s) for intra-band UL CA2.     Support transmission of SRS for xTyR (x=y) based antenna switching and SRS for CB/NCB /BM on different CCs in overlapped symbol(s) for intra-band UL CA |  | Yes | N/A |   | Per band | N/A | N/A | N/A |  | Optional with capability signalingNote: For component 1 and 2, a UE not reporting this component does not support the feature  |
| 22. NR Others | 22-5b | Simultaneous transmission of SRS for antenna switching and SRS for CB/NCB /BM for inter-band UL CA | 1.     Support transmission of SRS for xTyR (x<y) based antenna switching and SRS for CB/NCB /BM on different CCs in overlapped symbol(s) for inter-band UL CA2.     Support transmission of SRS for xTyR (x=y) based antenna switching and SRS for CB/NCB /BM on different CCs in overlapped symbol(s) for inter-band UL CA |  | Yes | N/A |   | Per BC | N/A | N/A | N/A |  | Optional with capability signalingNote: For component 1 and 2, a UE not reporting this component does not support the feature |
| 22. NR Others | 22-5c | Simultaneous transmission of SRS for antenna switching and SRS for antenna switching for intra-band UL CA | 1.     Support transmission of SRS for antenna switching and SRS for antenna switching on different CCs in overlapped symbol(s) for intra-band UL CA |  | Yes | N/A |   | Per band | N/A | N/A | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-5d | Simultaneous transmission of SRS for antenna switching and SRS for antenna switching for inter-band UL CA | 1.     Support transmission of SRS for antenna switching and SRS for antenna switching on different CCs in overlapped symbol(s) for inter-band UL CA |  | Yes | N/A |   | Per BC | N/A | N/A | N/A |  | Optional with capability signaling |
| 22. NR Others | 22-6 | Support of up to three different numerologies in the same NR PUCCH group for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups | Support of up to three different numerologies in the same NR PUCCH group for NR-CA where UE is not configured with two NR PUCCH groups 1) Which NR Carrier type(s) that can transmit NR PUCCH  |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Candidate values1. One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission

Note: RAN1 will discuss on how to handle the SDL or SUL band | Optional with capability signalling |
| 22. NR Others | 22-6a | Support of up to four different numerologies in the same NR PUCCH group for NR part of EN-DC, NGEN-DC, NE-DC and NR-CA where UE is not configured with two NR PUCCH groups | Support of up to four different numerologies in the same NR PUCCH group for NR-CA where UE is not configured with two NR PUCCH groups 1) Which NR Carrier type(s) that can transmit NR PUCCH  |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Candidate values1. One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission

Note: RAN1 will discuss on how to handle the SDL or SUL band | Optional with capability signalling |
| 22. NR Others | 22-7 | Support two PUCCH groups for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} | For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,* + the “primary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the primary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the primary PUCCH group
	+ the “secondary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the secondary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the secondary PUCCH group
	+ Note: for each {primary PUCCH group config, secondary PUCCH group config}, each carrier type of {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} is mapped to either or both of the primary PUCCH group config and the secondary PUCCH group config.
 |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Note: RAN1 will discuss on how to handle the SDL or SUL band, for example as below* SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly
* SDL having no overlapped TDD or FDD can follow the same principle with FDD

Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission* FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations

Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH groupFFS: SUL is counted as number of bands for the condition of this new FG reporting | Optional with capability signalling |
| 22. NR Others | 22-8 | For SRS for CB PUSCH and antenna switching on FR1 with symbol level offset for aperiodic SRS transmission   | For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission | 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-8a | PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-2
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-2, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-8b | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-8c | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a DCI gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5a
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5a, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-8d | All PDCCH monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a span gap and constrained timeline for SRS for CB PUSCH and antenna switching on FR1 | * A UE supports FG 3-5b
* For SRS for CB PUSCH and antenna switching on FR1, UE requires minimum of 19 symbols offset between aperiodic SRS triggering and transmission
 | 3-5b, 2-53 | Yes | N/A |   | Per FS(applicable to FR1 only) | n/a | n/a | n/a |   | Optional with capability signalling |
| 22. NR Others | 22-9 | Cancellation of PUCCH, PUSCH or PRACH with a DCI scheduling a PDSCH or CSI-RS or a DCI format 2\_0 for SFI | A UE supports the partial cancellation of the PUCCH or PUSCH or PRACH configured transmission: * The UE cancels the configured PUCCH or PUSCH or PRACH in a set of symbols of a slot due to detection of a DCI format 2\_0 with a slot format value other than 255 that indicates a slot format with a subset of symbols from the set of symbols as downlink or flexible
* The UE cancels the configured PUCCH or PUSCH or PRACH in a set of symbols of a slot due to the detection of a DCI format 1\_0, DCI format 1\_1, DCI format 1\_2 or DCI format 0\_1 and DCI format 0\_2 indicating to the UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols.
 |  | Yes | N/A |   | Per FS | n/a | n/a | n/a |   | Optional with capability signalling |