3GPP TSG-RAN WG4 Meeting #100-e R4-2115344

**Electronic Meeting, Aug 16 - 27, 2021**

**Agenda Item: 9.11.2.3**

**Source: Apple**

**Title: WF on R17 NR MG enhancement - NCSG**

**Document for: Discussion**

# **Introduction**

This WF is to capture all agreements and open issues for NCSG in RAN4#100e meeting based on email discussion [100-e][225] NR\_MG\_enh\_3.

# **Scenarios and use cases**

## **Issue 1-1: NCSG in FR2**

* Agreement:
	+ NCSG in FR2 shall be considered in this WI. How to indicate support of NCSG in FR2 is FFS.

## **Issue 1-2: Use case for different types of measurement with NCSG**

* Agreement:
	+ Confirm the agreements in RAN4#99e that NCSG can be used for:
		- Measurement on de-activated SCell
		- SSB based intra-frequency measurement with gap
		- SSB based inter-frequency measurement with gap
		- Inter-RAT E-UTRAN measurement
	+ It is FFS whether NCSG can be used for measurement on dormant SCell.
	+ It is FFS whether NCSG can be used for CSI-RS based inter-frequency measurement with gap.
* Agreement in the 2nd round:
	+ NCSG will not be used for 2G/3G measurements, CSI-RS based L3 measurements and PRS measurements.

## **Issue 1-3: Use case for different UE capability and network configuration**

* Open issues:
	+ Option 1: RAN4 to define UE measurement requirements with different UE capabilities and NW configurations as in the following table:

|  |  |  |  |
| --- | --- | --- | --- |
|  **NW config****UE capability** | **Case a:** **No MG nor NCSG** | **Case b:****NCSG** | **Case c:** **MG** |
| **Case 1: gap** | **No requirement** | **No requirement** | **Measurement within MG** |
| **Case 2: no-gap-with-interruption** | **No requirement** | **Measurement within NCSG with only NCSG interruption allowed** | **Measurement within MG with only legacy gap interruption allowed** |
| **Case 3: no-gap-no-interruption** | **Measurement without MG** | **Measurement outside NCSG** | **Measurement outside MG** |

* + Option 2: other solutions are not precluded.

## **Issue 1-4: Whether NW should configure the legacy MG rather than NCSG even UE can support both of them**

* Agreement:
	+ Even if UE supports NCSG then it is up to the NW implementation to configure the UE with legacy MG or with NCSG.”

## **Issue 1-5: Other applicability issues**

* Agreement in the 1st round:
	+ RAN4 to clarify whether to allow NCSG to be supported with NRDC and NEDC as well.
* Open issues:
	+ FFS: Existing gap applicability in Rel-16 for NR-only measurements and mandatory gap patterns is re-used for NCSG capable UEs.
	+ FFS: Related to NCSG applicability and UE capability support: if UE supports NCSG, it is mandated to support MG patterns from per-UE gap patterns #0, #1, #4-9 for NCSG usage. In case UE supports NCSG and per-FR gap patterns, indicating this via capability, it is mandated to support also per-FR gap patterns #12-19 in FR2 for NCSG usage.
	+ FFS: NCSG can be configured simultaneously with legacy MG pattern.
	+ FFS: NCSG can be pre-configured and will reuse the activation/deactivation mechanism developed for pre-configured measurement gaps.
	+ FFS: NCSG can be configured and activated together with concurrent measurement gaps.

# **NCSG pattern**

## **Issue 2-1: supported NCSG patterns in R17**

* Agreement in the 1st round:
	+ No need to introduce NCSG patterns corresponding to legacy MG patterns #24 and #25.
	+ It is FFS whether to introduce NCSG patterns with longer repetition periodicity (>160ms).
* Open issues:
	+ Corresponding minimum MGL
		- Option 1: 1.5ms
		- Option 2: 3ms
		- Option 3: 5.5ms
		- Option 4: 4ms for FR1 and 3.5ms for FR2
		- Option 5: 3ms for FR1 and 1.5ms for FR2
		- Option 6: Define NCSG patterns corresponding to legacy patterns #0~#23. Allow UE to separately indicate support of each NCSG pattern (some patterns can be mandatory if UE supports NCSG)
	+ Corresponding minimum MGRP
		- Option 1: 20ms
		- Option 2: 40ms
		- Option 3: Define NCSG patterns corresponding to legacy patterns #0~#23. Allow UE to separately indicate support of each NCSG pattern (some patterns can be mandatory if UE supports NCSG)

## **Issue 2-2: whether to define separate NCSG patterns for sync and async**

* Open issues:
	+ Option 1: yes
	+ Option 2: no
	+ Option 3: different patterns in FR1 but same patterns in FR2
	+ Option 4: FFS

## **Issue 2-3: whether to consider VIL as a part of NCSG pattern**

* Option 1:
	+ NOT consider VIL as a part of NCSG pattern, i.e. only keep measurement length and repetition periodicity in the pattern design, and capture VIL separately as interruption requirements (similar to Table 9.1.2-4 in TS38.133).
* Option 2:
	+ Keep VIL as a part of the NCSG pattern.

# **VIL, RRT and ML**

## **Issue 3-1: whether to replace VIL (visible interruption length) with RRT (RF retuning time)**

* Open issues:
	+ Option 1: Yes. Introduce absolute RRT to replace VIL.
	+ Option 2: VIL and RRT can be defined separately.
	+ Option 3: only capture VIL in RAN4 spec. RRT can be used to calculate ML in discussion. But no need to capture RRT in RAN4 spec.

## **Issue 3-2: how to capture VIL in RAN4 spec**

* Open issues:
	+ Option 1: based on the number of interrupted slots
	+ Option 2: based on the absolute time
* Note: issue 3-4 was concluded in the 1st round, which means VIL will be captured in RAN4 spec in terms of number of the interrupted slots. Therefore, no need to further discuss issue 3-2.

## **Issue 3-3: relation between ML, MGL and RRT**

* Open issues:
* Option 1: ML = MGL – 2\*RRT
	+ Option 1a: ML = MGL – 2\*RRT and ML + VIL1 + VIL2 > MGL
	+ Option 1b: ML = MGL – 2\*RRT and ML + VIL1 + VIL2 > MGL, if VIL is defined as the number of interrupted slots
	+ Option 1c: ML = MGL - RRT1 - RRT2
* Option 2: ML + VIL1 + VIL2 = MGL
	+ Option 2a: ML = MGL – VIL1 – VIL2, if VIL is defined as the absolute time
* Option 3:
	+ Step 1: **Define ML**NCSG from legacy gap patterns by MLNCSG = MGLlegacy – 2\*RRTlegacy, e.g.,
		- Gap patterns 0-11: MLNCSG = MGLlegacy – 1 (ms)
		- Gap patterns 12-23: MLNCSG = MGLlegacy – 0.5 (ms)
	+ Step 2: **Define RRTNCSG** before and after MLNCSG in FR1 and FR2
		- Handled by Issue 3-5, e.g., same or longer than RRTlegacy.
	+ Step 3: **Define MGLNCSG** as MLNCSG + 2\* RRTNCSG.
	+ Step 4: **Define VIL**
		- Handled by Issue 3-4

## **Issue 3-4: length of VIL**

* Agreements in the 1st round:
	+ Translate [1ms] (FR1) and [0.75ms] (FR2) into the number of interrupted slots for defining the interruption requirements for the synchronous case and one more slot is added for asynchronous case.

## **Issue 3-5: length of RRT**

* Agreements in the 1st round:
	+ The following RRT time can be used as assumption to derive ML
		- RRT = 0.5 ms for FR1 and 0.25 ms for FR2
	+ Whether to capture above RRT time in RAN4 spec is FFS.

## **Issue 3-6: impact from RTD**

* Open issues:
	+ FFS: RAN4 to further discuss how to address RTD between time reference cell and victim cell.

## **Issue 3-7: UL slot after VIL1**

* Open issues:
	+ FFS: RAN4 to further discuss how to address UL slot immediately after VIL1 in the interruption requirements.

# **UE capability and network configuration of NCSG**

## **Issue 4-1: whether additional NCSG capability for per-UE and per-FR differentiation is needed on top of existing per-UE and per-FR capability**

* Open issues:
	+ Option 1: no.
	+ Option 2: yes. Introduce per BC indication of per FR NCSG in Rel-17.The discussion can be postponed till progress is made towards per BC indication for per FR UE capability.

## **Issue 4-2: how to indicate the support of NCSG pattern**

* Open issues:
	+ Option 1: introduce new signalling (separately from NeedForGap) to indicate support of NCSG.
	+ Option 2: introduce new element in NeedForGap to indicate support of NCSG.
	+ Option 3: introduce new signalling (separately from NeedForGap) to indicate support of following cases
		- Case 1: gap
		- Case 2: no-gap-with-interruption (or NCSG)
		- Case 3: no-gap-no-interruption
	+ Option 4: up to RAN2.

## **Issue 4-3: whether RAN4 needs to decide whether UE is allow to report ‘no gap’, ’NCSG’ and ‘gap’ capabilities to different bands. The UE behaviour and the corresponding measurement requirements are highly depending on how signaling will be provided and UE capability will be reported.**

* Open issues:
	+ Option 1: yes
	+ Option 2: FFS

## **Issue 4-4: configuration of NCSG.**

* Open issues:
	+ Option 1: Support the explicit configuration for NCSG (detail to be left to RAN2).
	+ Option 2: Introduce a single bit for existing MeasGapConfig to transform the legacy gap into NCSG (detail to be left to RAN2).
	+ Option 3: postpone until NCSG pattern design as well as NCSG applicability and UE capability support are finalized

## **Issue 4-5: Mapping/relation between NCSG and legacy MG patterns.**

* Open issues:
	+ FFS: Introduce mapping table between legacy measurement gap patterns and corresponding NCSG patterns for the UE and gNB to determine the transform gap pattern. Details of mapping are FFS.
	+ FFS: When UE supports NCSG, the supported gap pattern index shall be the same as its reported legacy MG pattern capability in Rel-15/16.
	+ FFS: Use the same index for legacy MGP and its corresponding NCSG pattern.

# **Measurement related requirements**

## **Issue 5-1: CSSF design**

* Open issues:
	+ Option 1: define a new CSSF dedicated for NCSG measurement
	+ Option 2: When NCSG is configured, for a frequency layer that can be measured without MG, Kp = 1/(1- (SMTC period /VIRP)) applies when SMTC period < VIRP; when SMTC period >= VIRP, the frequency layer should be measured within NCSG and be accounted in the CSSF calculation.
	+ Other options are not precluded.

## **Issue 5-2: scheduling restriction**

* Open issues:
	+ Option 1: during the ML the existing scheduling restriction requirements defined in TS 38.133 shall also apply
	+ Option 2
		- For intra-frequency measurement, existing scheduling restriction requirements apply.
		- For inter-frequency measurement and the target carrier and the serving cell are in same band, existing scheduling restriction requirements apply except that all symbols in SMTC windows are restricted.
		- For inter-frequency measurement and the target carrier and the serving cell are in different bands, all symbols in SMTC windows are restricted when scheduling restrictions apply, and whether scheduling restrictions apply depends on UE capability.
		- NW should be informed whether UE needs scheduling restriction or not for a combination of an inter-frequency target carrier and a serving cell.
	+ Option 3: The existing scheduling restriction requirements defined in TS 38.133 for FR1 shall apply during ML when serving and measured carriers are in FR1. No scheduling restriction is allowed for FR2 during ML when serving carrier and measured carriers are in FR2 and use IBM.
	+ Option 4: Scheduling restriction for NCSG is FFS, and check with RAN2 on the feasibility of informing NW the CBM or IBM between inter-frequency measurements and serving cells in FR2.

# **Other RRM requirements**

## **Issue 6-1: requirements for interruption due to NCSG based measurement on deactivated SCC**

* Open issues:
	+ Option 1: existing requirements shall be revisited
	+ Option 2: FFS

# **Reference**

[1] R4-2115215, Email discussion summary for [100-e][225] NR\_MG\_enh\_3, Apple