**3GPP TSG-RAN WG4 Meeting #98-e R4-200XXXX**

**Electronic Meeting, Jan 25– Feb 5, 2021**

**Agenda item:** 11.5.2.1 & 11.5.2.3

**Source:** Moderator (Intel Corporation)

**Title:** Email discussion summary for [98e][234] NR\_MG\_Part\_2

**Document for:** Information

# Introduction

The scope of this email discussion is UE RRM requirements for NR positioning from the following agenda items:

* AI 11.5.2.1 Pre-configured MG pattern
* AI 11.5.2.3 Network Controlled Small Gap

In providing comments, companies are encouraged to:

* Be concise
* Provide comments on all topics/sub-topics of interest
* Ensure that comments are inserted in the latest version of the document by checking the folder before uploading
* Use “Track changes” to help identify added comments/changes

# Topic #1: Pre-configured MG pattern(s)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2100221**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2100221.zip) | Apple | **Proposal 1: different MG pattern can be preconfigured for different BWP.**  **Proposal 2: associated MG pattern shall be activated/deactivated upon BWP switch.**  **Observation 1: If BWP switching occurs with no impact on measurement sampling rate on all the carriers to be measured, it is possible for UE to perform L1 averaging on samples before and after BWP switching. Measurement requirements may remain the same before and after BWP switching.**  **Observation 2: If BWP switching occurs with impact on measurement sampling rate. Measurement period would be different after BWP switch and corresponding measurement requirements need to be updated.**  **Proposal 3: RAN4 is to discuss the impact on measurement requirement for the following scenario:**   * **BWP switching occurs with impact on measurement sampling rate.**   **Proposal 4: if BWP switch delay happens to collide with RS to be measured, extra measurement delay is expected.** |
| [**R4-2100454**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2100454.zip) | CATT | **Observation 1: For the DCI-based or timer-based BWP switch, the UE measurement delay may be prolonged for the case that the active BWP switch triggers a gap-based measurement while the UE performs measurement without gap before active BWP switch or the case the gap pattern needed for UE measurement varies before and after active BWP switch.**  **Observation 2: Compared to the current gap configuration, pre-configured gap pattern have no improvement or degradation for case 1 and 4, but can save the processing delay of gap configuration and release by RRC signaling for case 2, 3 and 5.**  **Proposal 1: There can be at most N MG patterns can be pre-configured for each active BWP where N is the maximum number of concurrent and independent gap patterns.**  **Proposal 2: The activation/deactivation of pre-configured MG pattern follows the same DCI-based or time-based indication as active BWP switch.**  **Proposal 3: The pre-configured gap pattern can be applied for all five cases below:**   * **Case 1: MG is not needed for UE measurement before and after active BWP switch;** * **Case 2: MG is not needed for UE measurement before active BWP switch and is needed after active BWP switch;** * **Case 3: MG is needed for UE measurement before active BWP switch and is not needed after active BWP switch;** * **Case 4: Same MG is needed for UE measurement before and after active BWP switch;** * **Case 5: Different measurement gaps are needed for UE measurement before and after active BWP switch;** |
| [**R4-2100712**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2100712.zip) | Xiaomi | **Proposal 1: RAN4 is to introduce a dynamic activation/deactivated mechanism for measurement gap configuration that matches the active BWP switching.**  **Proposal 2: The activation/deactivation of measurement gap is indicated in the same DCI command as the BWP activation.**  **Proposal 3: If there is one or more active BWP switching during one measurement period, the relaxed measurement requirement corresponding to the measurement without gap and the measurement with gap shall be applied** |
| [**R4-2100871**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2100871.zip) | CMCC | ***Observation 1: there may be different mechanism to introduce pre-configured MG pattern. Different mechanism may have different impact on the requirements specification or UE behavior.***  ***Proposal 1: it is necessary to decide the mechanism of pre-configured MG pattern firstly before the detail discussion on the requirements specification*** |
| [**R4-2101062**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101062.zip) | MediaTek inc. | ***Proposal 1: The dynamic MG ON/OFF mechanism can be implicitly triggered by BWP switch via DCI command or Timer.***  ***Proposal 2: If NW configures inter-frequency or Inter-RAT MOs which still need MG, the fast MG should always be ON.***  ***Proposal 3: When there is only one active serving cell and NW only configures one intra-frequency MO, the fast MG can be ON/OFF according to the BWP switch.***  ***Proposal 4: In NR CA, when only intra-frequency MOs are configured and all intra-frequency measurements do not need MG, the fast MG can be OFF.***  ***Proposal 5: After BWP switching, if any of intra-frequency measurement still needs MG, the fast MG should still be ON.***  ***Proposal 6: Due to no dynamic coordination between MN and SN, the fast MG mechanism is not applied in DC scenario.*** |
| [**R4-2101269**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101269.zip) | Intel Corporation | **Observation 1**. **The gap for PRS measurement shall be configured immediately when UE is requested to measure PRS. That is the gap for PRS measurement is independent from the BWP switching.**  **Observation 2**. **The pre-configured gap can be helpful to reduce MG configuration delay for CSI-RS measurement significantly.**  **Observation 3**. **When BWP switching is done on multiple CCs, the criteria to justify whether the pre-configured gap is needed is same as that of when BWP switching on single CC.**  ***Proposal 1: RAN4 can consider the application scenarios of the pre-configured gap for single CC BWP switching below as a starting point.***   * ***Scenario 1: intra-frequency SSB based measurement before BWP switching*** * ***Scenario 2: intra-frequency CSI-RS measurement before BWP switching***   ***Proposal 2: Do not define separate activation delay requirements for the pre-configured MG activation.***  ***Proposal 3: Do not define interruption requirements due to pre-configured MG activation.***  **Observation 4: The same RF switching time when considering pre-configured gap pattern as the legacy gap patterns in NR [3] can be reused.**  **Observation 5: MGL of the pre-configured gap patterns can also rely on the measurement type (e.g. SSB or CSI-RS).**  **Observation 6: The shorter MGL can be considered because of the perfect synchronization of measured BWP.**  ***Proposal 4 :* *The existing gap patterns in Rel16 [3] can be reused for the pre-configured MG depending on the configuration of the targeted measurements reference signal.***  **Observation 7: It is feasible to include the pre-configured gap as one of instance of multiple concurrent gap pattern if UE supported.**  ***Proposal 4a: The RAN4 minimum requirements for intra-frequency SSB measurement can follow that of intra-frequency SSB measurement requirements with gap specified in*** *9.2.6* ***of TS38.133 [3].***  ***Proposal 4b: The RAN4 minimum requirements for intra-frequency SSB measurement and CSI-RS measurement with pre-configured MG can follow that of intra-frequency SSB measurement requirements with gap specified in*** *9.2.6* ***of TS38.133 [3] and inter-frequency CSI-RS measurement requirements specified in*** *9.10.3* ***of TS38.133 [3] respectively.***  ***Proposal 5: The applicability of pre-configured MG shall be per-UE.***  **Observation 7: There are no restrictions on the total number of preconfigured gaps.**  **Observation 8: The serving gNB need not activate all pre-configured gaps but part of them depending on the measurement configuration and bwp-InactivityTimer[4].** |
| [**R4-2101381**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101381.zip) | vivo | **Proposal 1: To enable measurement gap activation/deactivation after a BWP switch, one potential solution is to build a relationship between one particular BWP and one particular measurement gap configuration, which requires corresponding RAN2 signalling design**  **Proposal 2: Regarding rules for measurement gap activation/deactivation, either network centralized or UE centralized rules will work.**  **Proposal 3: For the fast MG configuration feature, within a particular measurement duration, the measurement requirements may need switch between “with gap” requirements and “without gap” requirements after a BWP switch. In addition, a transition period may need be defined for such a switch** |
| [**R4-2101537**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101537.zip) | OPPO | **Observation 1: The activation/deactivation of per-configured MG in BWP configuration rely on activation/deactivation of BWP following a DCI or timer based BWP switch.**  **Proposal 1：Per-configured MG in one active BWP can over-ride current RRC configured MG until active BWP switch to a new BWP without per-configured MG pattern.**  **Proposal 2: per-configured MG pattern should comply with current requirements of NR MG pattern 0~23.**  **Proposal 3: Per BWP MG configuration become valid once this BWP become active, with no extra impact on current BWP switch delay.**  **Proposal 4：All mandatory gaps for UE should be able to be supported by pre-configured BWP MG configuration.**  **Proposal 5：The applicability of current per FR gap pattern should also apply for per BWP MG configuration.**  **Proposal 6：Limit the available pre-configured MG patterns within the most commonly used MG patterns.**  **Proposal 7：Only 1 gap pattern is allowed to per-configured for each BWP. Different gap pattern is allowed to be configured for different UE BWP.** |
| [**R4-2102268**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102268.zip) | Nokia, Nokia Shanghai Bell | 1. RRC signalling for configuring measurement gaps has been used due to the signalling robustness. 2. Errors in measurement gap configuration can have significant negative UE and system impact. 3. it is important that changes in the measurement gaps are signalled in a robust way. 4. RAN4 need to account robustness of the gap changes when evaluating and agreeing on activation/deactivation of MG pattern(s). 5. RAN4 will need to agree on one or more evaluation parameters for selection of the mechanisms of activation and deactivation of MG. 6. MGP change delay shall be evaluated based on realistic latencies. 7. Robustness shall be evaluated including the final signal loss probability. 8. Analyse and evaluate, under realistic assumption, the possible impact on cell detection from a change in MGP. 9. Analyse and evaluate, under realistic assumption, the possible impact on the measurement period from a change in MGP. |
| [**R4-2102622**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102622.zip) | Qualcomm CDMA Technologies | **Proposal1: RAN4 should focus on the binary enablement of an MG for a BWP when defining the requirements for pre-configured MG pattern.**  **Proposal1.1: RAN4 may further discuss whether and how multiple concurrent MG patterns can be associated with each BWP depending on the work progress of multiple concurrent and independent MG patterns**.  **Proposal2: RAN4 needs to clarify if pre-configured MG patterns are referenced to the BWPs of PCELL or PSCELL and can be assumed for all the other activated SCells since per CC MG is not supported.**  **Proposal2.1: If per UE MG is configured, the BWP of PCell is referenced to activate its MG pattern which applies to all the serving carriers including PSCell and SCells.**  **Proposal2.2: If per FR MG is configured, BWPs of PCell and PSCell are referenced respectively to decide the pre-configured MGs for applying to the SCells of respective FR.**  **Proposal2.3: RAN4 may discuss the applicability of preconfigured MG for ENDC and/or NEDC.**  **Proposal3: RAN4 shall seek clarifications from RAN2 on the signalling design for enabling and disabling the pre-configured MG pattern per BWP.**  **Proposal4: RAN4 to discuss a time separation of [X]ms from a BWP switch completion to a new MG entry.**  **Proposal4.1: RAN4 to discuss if it’s needed to introduce a time separation of [Y]ms from BWP switch is triggered by DCI to the start of an up-coming gap, before which, UE shall abort the gap.** |
| [**R4-2102655**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102655.zip) | Ericsson | **Current status of measurement requirements for measurement without gaps:**   * **Observation # 1**: If an active BWP switch occurs during a measurement being performed without gaps (i.e. within active BWP) and if the new active BWP after the active BWP switching does not fully contain the measured SSB then the UE does not continue the ongoing measurement. * **Observation # 2**: If an active BWP switch occurs during a measurement being performed without gaps (i.e. within active BWP) and the new active BWP after the active BWP switching does not fully contain the measured SSB then the UE is not required to continue the measurement even if gaps are provided or available.   **Scenarios for using pre-configured measurement gaps:**   * **Proposal # 1**: If an active BWP switch occurs while UE is performing a measurement without gaps active and the new active BWP after the active BWP switching does not fully contain the measured SSB then the UE shall continue the ongoing measurement using pre-configured measurement gaps (i.e. if gaps are already available). * **Proposal # 2**: If an active BWP switch occurs while UE is performing a measurement with gaps (i.e. outside active BWP) and the new active BWP after the active BWP switching fully contains the measured SSB then the UE shall continue the measurement without measurement gaps.   **Transition time for switching between gapless and pre-configured gap-based measurement procedure:**   * **Observation # 3**: The UE needs some transition time (ΔT) to continue the ongoing measurement when active BWP switching requires the UE to switch between gap-based measurement procedure and gapless measurement procedure. * **Proposal # 3**: The transition time (ΔT1), to continue the ongoing measurement when active BWP switching requires the UE to switch from gapless measurement procedure to gap based measurement procedure, consists of active BWP switching delay (δt) and the maximum of the margin needed by the UE (Tmargin1, UE) and the margin needed by gNB (Tmargin1, gNB); where Tmargin1, UE and Tmargin1, gNB are FFS. * **Proposal # 4**: The transition time (ΔT2), to continue the ongoing measurement when active BWP switching requires the UE to switch from gap-based measurement procedure to gapless measurement procedure, consists of active BWP switching delay (δt) and the maximum of the margin needed by the UE (Tmargin2, UE) and the margin needed by gNB (Tmargin2, gNB); where Tmargin2, UE) and Tmargin2, gNB are FFS.   **Frequency and number of transitions allowed during measurement period**:   * **Observation # 4**: Too frequently switching between gapless measurement procedure and gap-based measurement procedure may lead to measurement instability and may also not give gNB enough opportunity to adapt scheduling. * **Proposal # 5**: RAN4 is to investigate the maximum number of transitions (N1,max) allowed for switching from gapless measurement procedure to gap-based measurement procedure during the ongoing measurement. * **Proposal # 6:** RAN4 is to investigate the maximum number of transitions (N2,max) allowed for switching from gap-based measurement procedure to gapless measurement procedure during the ongoing measurement. * **Proposal # 7**: If an active BWP switch occurs while UE is performing a measurement with gaps for the last at least X subframes and the new active BWP after the active BWP switching fully contains the measured SSB only then the UE shall continue the ongoing measurement without measurement gaps; otherwise the UE shall continue the ongong measurement using pre-configured gaps.   **Measurement period for measurement partially performed with and without gaps:**   * **Observation # 5**: The total measurement period for measurement partially performed with and without gaps needs will be impacted due to transition period and the number of transitions during the measurement period. * **Proposal # 8**: Total measurement period (Tmeasure, total) can be expressed in terms of basic measurement period (Tmeasure, basic) and aggregated time consumed due to total number of transitions between gapless measurement procedure and gap-based measurement procedure during the ongoing measurement. * **Proposal # 9**: In proposal 8, Tmeasure, basic can be expressed as: Tmeasure, basic = MAX(TBWP, TG); where:   + TBWP= It is the measurement period when the measurement is fully performed without measurement gap   + TG= It is the measurement period when the measurement is fully performed with measurement gap.   **Scheduling restriction during pre-configured gaps when they are not used:**   * **Proposal # 10**: If the UE is measuring without pre-configured gaps and no other frequency layer which needs gaps is configured then the UE can be scheduled during the pre-configured gaps while meeting existing scheduling restriction requirements defined in TS 38.133. |
| [**R4-2102810**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102810.zip) | Huawei, HiSilicon | **Proposal 1: RAN4 to work on the activation/deactivation of the pre-configured per UE or per FR gap following BWP switch.**   * **When the MG is activated, the MG pattern applies to both serving cell scheduling and RRM measurement, same as how configured MG is applied in Rel-16** * **When the MG is deactivated, there would be no MG interruption on the corresponding serving cells, and the corresponding RRM measurements are performed without MG**   **Proposal 2: A per-UE or per-FR MG is (de)activated following a BWP switch as follows:**   * **If MG is not required by any of the configured MOs, the MG is deactivated** * **If MG is required by one or more of the configured MOs, the MG is activated**   **Proposal 3: The delay of MG (de)activation is same as that of BWP switching. No interruption requirement is needed for MG (de)activation.**  **Proposal 4: With one or more MG (de)activation in the measurement period, the transition requirements in clause 9.1.6 apply.**  **Proposal 5: RAN4 to further discuss whether and how MG (de)activation applies in MR-DC considering at least the following challenges:**   * **MN/SN is not aware of BWP switching in the SN/MN** * **SN is not aware of the MO configuration from MN** |

## Open issues summary

Pre-configured MG objectives of this WI are as follows:

*Pre-configured MG pattern(s) (fast MG configuration) [RAN4, RAN2]*

* + *RRM requirements for pre-configured MG pattern(s) [RAN4]*
    - *Study requirements of the mechanisms of activation/deactivation of MG following a DCI or timer-based BWP switch, e.g., per BWP MG configuration*
    - *Specification of rules and UE behaviour for activation/deactivation of a MG following a DCI or timer-based BWP switch*
    - *Define measurement period requirements with pre-configured MG pattern(s) in the presence of one or more BWP switch per measurement period*
  + *Specification of applicability of pre-configured MG pattern(s) [RAN4]*
  + *Procedures and signaling for pre-configured MG pattern(s) [RAN2]*
    - *Specification of protocol impacts of the mechanisms of activation/deactivation of MG following a DCI or timer-based BWP switch, e.g., per BWP MG configuration based on RAN4 input*

### Sub-topic 1-1 Definition and using scenarios for Pre-configured measurement gap

#### **Issue 1-1-0 Definition of pre-configured MG**

*[Moderator Notes* *: as there are some ambiguities on what is exactly preconfigured MG in WID, it is better to align RAN4’s understanding on this essential issue before further discussion. Thus please companies provide your views on these options below.]*

* Option 1:
  + Pre-configured MGs are defined per BWP. That is the network uses RRC to configure multiple MGs for a BWP. Then DCI will be used to indicate which MG to be used to UE.
* Option 2:
  + Pre-configured MGs are defined per UE or per FR which are same as these of legacy MGs. The only difference in comparison with the legacy MGs is how to enable them. For the pre-configured MG, UE and network use the BWP status (e.g. whether BWP contains the SSB) to determine whether the MG should be activated (ON) or dis-activated (OFF)

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-1-1 Whether the pre-configured MG can be defined depending on whether MGs is needed before/after BWP switching?**

*[Moderator Notes:* *these scenarios below defined by the different companies are mainly based on whether the gap is needed or not before/after BWP switching. Therefore, companies are encouraged to input the simple answers in the table below to identify the necessary using scenarios of pre-configured MG]*

* Option 1:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Case Index | Whether the MG needed before BWP switching | Whether MG needed after BWP switching | Whether the pre-configured MG can be used? | Supporting companies | Notes |
| 1 | No | No | Yes | CATT |  |
| No | Intel |  |
| 2 | No | Yes | Yes | CATT, Intel, |  |
| No |  |  |
| 3 | Yes | No | Yes | CATT |  |
| No |  |  |
| 4-1 | Yes | Yes | Yes | CATT |  |
| No | Intel |  |
| 4-2 | Yes | Yes, but with the different MGs with that of before BWP switching | Yes | CATT |  |
| No |  |  |

* Option 2: There is no directly relation between BWP switch and MG configuration. (MTK)
* When there is only one active serving cell and NW only configures one intra-frequency MO, the fast MG can be ON/OFF according to the BWP switch.
* If NW configures inter-frequency or Inter-RAT MOs which still need MG, the fast MG should always be ON.
* After BWP switching, if any of intra-frequency measurement still needs MG, the fast MG should still be ON.
* Option 3 (Ericsson):
  + Using pre-configured gaps:
    - If new active BWP after the active BWP switching does not fully contain the measured SSB then the UE continues the measurement using pre-configured measurement gap.
  + Stop using pre-configured gaps:
    - If new active BWP after the active BWP switching fully contains the measured SSB then the UE continue the measurement without measurement gaps.

#### **Issue 1-1-2 Whether the pre-configured MG for the BWP switching on multiple CCs shall be considered?**

*[Moderator Notes: Regarding to the BWP switching on the multiple CCs, the above question shall be clarified firstly]*

* Option 1a (Apple): Yes. . And different MG pattern can be preconfigured for different BWP.
* Option 1b (Intel): Yes, but it shall be deprioritized.
* Option 1c (Qualcomm, Huawei): Yes, but it shall be subject to some clarifications.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-1-3 Whether pre-configured MGs are applicable in MR-DC scenario**

*[Moderator Notes: This scenario is focus on the BWP switching on single CC.]*

* Option 1(Huawei) RAN4 to further discuss whether and how MG (de)activation applies in MR-DC considering at least the following challenges:
  + MN/SN is not aware of BWP switching in the SN/MN
  + SN is not aware of the MO configuration from MN
* Option 2(MTK) Due to no dynamic coordination between MN and SN, the fast MG mechanism is not applied in DC scenario.

Recommended WF: Further discussion needed. Collect companies’ views

#### **Issue 1-1-4 Whether the pre-configured gaps shall be considered as a part of multiple concurrent gap patterns framework**

* Option 1: (Qualcomm, Intel)
  + It is feasible to include the pre-configured gap as one of instance of multiple concurrent gap pattern if UE supported. But RAN4 can focus on the separated pre-configured MG firstly.

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 1-2 Pre-configured MG activation/deactivation

#### **Issue 1-2-1 Pre-configured MG activation/deactivation mechanism**

* Option 1 (Apple, CATT, MTK, Intel, OPPO, Xiaomi, Huawei, Ericsson) Autonomously/implicitly triggered by BWP switching DCI/Timer.
* Option 1a (Huawei) A per-UE or per-FR MG is (de)activated following a BWP switch as follows:
  + If MG is not required by any of the configured MOs, the MG is deactivated
  + If MG is required by one or more of the configured MOs, the MG is activated
* Option 2 (vivo) Either network centralized or UE centralized rules will work.
* Option 3 (Nokia): RAN4 need to account robustness of the gap changes when evaluating and agreeing on activation/deactivation of MG pattern(s).

*[Moderator notes: Option 3 is separated issue listed in 1-2-2]*

* + Robustness shall be evaluated including the final signal loss probability.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-2-2 Evaluation on MG activation/deactivation mechanism**

* Option 1 (Nokia)
  + RAN4 need to account robustness of the gap changes when evaluating and agreeing on activation/deactivation of MG pattern(s).
  + RAN4 will need to agree on one or more evaluation parameters for selection of the mechanisms of activation and deactivation of MG.
  + MGP change delay shall be evaluated based on realistic latencies.
  + Robustness shall be evaluated including the final signal loss probability.
  + Analyse and evaluate, under realistic assumption, the possible impact on cell detection from a change in MGP.
  + Analyse and evaluate, under realistic assumption, the possible impact on the measurement period from a change in MGP.

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 1-3 RRM requirements

#### **Issue 1-3-1 Activation/Deactivation Delay**

* Option 1 (Intel, OPPO): No separated activation delay for the pre-configured MG activation/deactivation
* Option 2. (Ericsson, Qualcomm, vivo): some transition time (ΔT) shall be included in the pre-configured MG activation/deactivation time.
* Option 3 (Huawei): The delay of MG (de)activation is same as that of BWP switching.
* Option 4 (Nokia): MGP change delay shall be evaluated based on realistic latencies.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-3-2 Interruption requirements**

* Option 1. (Apple, Intel, Huawei): No
* Option 2 (Qualcomm): Yes. RAN4 to address how to capture the NCSG resulted interruptions in addition to the signal characteristics requirements on interruption in the existing

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-3-3 Measurement period**

* Option 1 (Apple) RAN4 is to discuss the impact on measurement requirement for the following scenario:
  + - BWP switching occurs with impact on measurement sampling rate
* Option 2. (Ericsson): Total measurement period (Tmeasure, total) can be expressed in terms of basic measurement period (Tmeasure, basic) and aggregated time consumed due to total number of transitions between gapless measurement procedure and gap-based measurement procedure during the ongoing measurement.
* Option 3 (Intel)
  + The RAN4 minimum requirements for intra-frequency SSB measurement can follow that of intra-frequency SSB measurement requirements with gap specified in 9.2.6 of TS38.133 [3].
  + The RAN4 minimum requirements for intra-frequency SSB measurement and CSI-RS measurement with pre-configured MG can follow that of intra-frequency SSB measurement requirements with gap specified in 9.2.6 of TS38.133 [3] and inter-frequency CSI-RS measurement requirements specified in 9.10.3 of TS38.133 [3] respectively.
* Option 4 (Xiaomi)
  + If there is one or more active BWP switching during one measurement period, the relaxed measurement requirement corresponding to the measurement without gap and the measurement with gap shall be applied**.**
* Option 5 (Huawei)
  + With one or more MG (de)activation in the measurement period, the transition requirements in clause 9.1.6 apply.
* Option 6 (Nokia):
  + Analyse and evaluate, under realistic assumption, the possible impact on cell detection from a change in MGP.
  + Analyse and evaluate, under realistic assumption, the possible impact on the measurement period from a change in MGP.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-3-4 Transitions between gapless and gap-based measurement procedures during ongoing measurements**

* Option 1(Ericsson):
  + RAN4 is to investigate the maximum number of transitions (N1,max) allowed for switching from gapless measurement procedure to gap-based measurement procedure during the ongoing measurement.
  + RAN4 is to investigate the maximum number of transitions (N2,max) allowed for switching from gap-based measurement procedure to gapless measurement procedure during the ongoing measurement
* Option 2 (Nokia):
  + Analyse and evaluate, under realistic assumption, the possible impact on cell detection from a change in MGP.
  + Analyse and evaluate, under realistic assumption, the possible impact on the measurement period from a change in MGP.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-3-5 Whether there is scheduling restriction during pre-configured MGs when not used.**

* Option 1 (Ericsson): If the UE is measuring without pre-configured gaps and no other frequency layer which needs gaps is configured then the UE can be scheduled during the pre-configured gaps while meeting existing scheduling restriction requirements defined in TS 38.133.

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 1-4 MG pattern configurations

#### **Issue 1-4-1 Number of pre-configured MG patterns**

* Option 1. (Apple, Intel, OPPO): different MG pattern can be preconfigured for different BWP.
* Option 1a (CATT) There can be at most N MG patterns can be pre-configured for each active BWP where N is the maximum number of concurrent and independent gap patterns
* Option 1b (Intel)
  + There are no restrictions on the total number of preconfigured gaps.
  + The serving gNB need not activate all pre-configured gaps but part of them depending on the measurement configuration and bwp-InactivityTimer.
* Option 1c (OPPO) Only 1 gap pattern is allowed to per-configured for each BWP. Different gap pattern is allowed to be configured for different UE BWP.
* Option 2 (Qualcomm) RAN4 may further discuss whether and how multiple concurrent MG patterns can be associated with each BWP depending on the work progress of multiple concurrent and independent MG patterns.
* Option 3 (Huawei): RAN4 to work on the activation/deactivation of the pre-configured per UE or per FR gap following BWP switch

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-4-2 MG patterns used for the pre-configured MG mechanism**

* Option 1. (Intel, OPPO): The existing gap patterns (0~23) in Rel16 can be reused for the pre-configured MG.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-4-3 Relation of pre-configured MG pattern and with the current RRC configured MG**

* Option 1. (OPPO): Pre-configured MG in one active BWP can over-ride current RRC configured MG until active BWP switch to a new BWP without per-configured MG pattern.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 1-4-4 Per-UE/Per-FR pre-configured MG pattern applicability**

* Option 1 (Intel)
  + If the gap patterns which can be used as the pre-configured gap are reused from Rel16, the same applicability(per-UE/per-FR) shall follow the rules defined in Rel16 also.
* Option 1a (Qualcomm):
  + If per UE MG is configured, the BWP of PCell is referenced to activate its MG pattern which applies to all the serving carriers including PSCell and SCells.
  + If per FR MG is configured, BWPs of PCell and PSCell are referenced respectively to decide the pre-configured MGs for applying to the SCells of respective FR.
* Option 1b(OPPO)
  + The applicability of current per FR gap pattern should also apply for per BWP MG configuration

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 1-5 RAN2 Singling

#### **Issue 1-5-1 Signaling to enable the pre-configured MGs**

* Option 1(Qualcomm) RAN4 shall seek clarifications from RAN2 on the signalling design for enabling and disabling the pre-configured MG pattern per BWP.
* Option 1a(vivo). To enable measurement gap activation/deactivation after a BWP switch, one potential solution is to build a relationship between one particular BWP and one particular measurement gap configuration, which requires corresponding RAN2 signalling design

*[Moderator Notes: subject to the conclusion of Issue 1-2-1 Pre-configured MG activation/deactivation mechanism. E.g. If the autonomous activation is feasible, such signalling is not needed]*

Recommended WF: Further discussion needed. Collect companies’ views.

## Companies views’ collection for 1st round

### Open issues

#### Sub-topic 1-1 Definition and using scenarios of Pre-configured measurement gap

**Issue 1-1-0 Definition of pre-configured MG**

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| **Company** | **Comments** |
| MTK | This is a fundamental issue for pre-configured meas. gap.  BWP switch only relates to whether intra-frequency layer needs gap or not. There is no directly relation between BWP switch and the MG configuration.  The total interruption of MG depends on all configured MOs per-UE other than depending on the BWP switch. Thus, NW cannot use DCI to dynamically indicate which MG can be used to UE by BWP switching.  Whether NW configures a MG depends on the measurements for all the frequency layers, including inter-frequency, inter-RAT etc. The most straightforward way to determine whether the pre-configured MG is needed is to go through all the configured MOs and check if MG is required by any of them.  Before NW go through all the configured MOs, NW doesn’t know whether MG is needed and which MG pattern shall be configured. |
| Apple | According to the WID scope:   |  | | --- | | * + RRM requirements for pre-configured MG pattern(s) [RAN4]     - Study requirements of the mechanisms of activation/deactivation of MG following a DCI or timer based BWP switch, e.g., per BWP MG configuration     - Specification of rules and UE behaviour for activation/deactivation of a MG following a DCI or timer based BWP switch     - Define measurement period requirements with pre-configured MG pattern(s) in the presence of one or more BWP switch per measurement period   + Specification of applicability of pre-configured MG pattern(s) [RAN4]   + Procedures and signaling for pre-configured MG pattern(s) [RAN2]     - Specification of protocol impacts of the mechanisms of activation/deactivation of MG following a DCI or timer based BWP switch, e.g., per BWP MG configuration based on RAN4 input |   RAN4 should study per BWP MG configuration. Mechanism of activation/deactivation of MG should follow a DCI or timer based switch.  Based on this assumption, our understanding is that pre-configured MG is defined per BWP. Take following scenario for example:  Diagram  Description automatically generated  Certain MG pattern is preconfigured associated with BWP2, while no MG is preconfigured associated with BWP1. The MG pattern will be activated/deactivated along with the BWP switching, i.e. when UE switches from BWP1 to BWP2, MG will be activated. When UE switches from BWP2 to BWP1, MG will be deactivated.  To extend the concept, we expect network uses RRC to configure a single MG pattern for each BWP (mixed operation with multiple concurrent MGs is not considered here). Actual MG pattern may be distinct for different BWP. The active MG pattern is determined by the associated active BWP. Since there is up to only one active BWP, there is only one active MG at a time.  Therefore, our understanding is close to option 2 but not exactly same as neither option 1 nor option 2. We propose option 3:   * **Option 3:**   + **Pre-configured MG is defined per BWP. That is the network uses RRC to configure MGs for each BWP. The active MG should be determined based on the active BWP.** |
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**Issue 1-1-1 Whether the pre-configured MG can be defined depending on whether MGs is needed before/after BWP switching**

*[Moderator Notes:* *Companies are encouraged to input the simple answers in the table below to identify the necessary using scenarios of pre-configured MG]*

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| **Company** | **Comments** |
| MTK | Option 2.  RAN4 needs to clarify Issue 1-1-0 firstly.   * In MR-DC, due to no dynamic coordination (BWP switch is a L1 procedure) between MN and SN, the fast MG mechanism is not applied. * In NR SA, if there is any of intra-frequency, inter-frequency, or inter-RAT MO needs MG, the fast MG shall be ON. * In NR SA,   + if UE supports inter-frequency measurement without MG, and the SSB is completely contained in the active BWP or   + if there is intra-frequency MOs, and all of intra-frequencies’ active BWPs include SSB,   the fast MG can be OFF. |
| Apple | It is better for RAN4 to reach consensus on issue 1-1-0 first.  In above option 1&2&3, seems there are quite a lot of conditions to check if the MG should be ON or OFF. Actually, situation could be much more complicated. For instance, we also need to consider different SCS and whether UE can support mixed numerologies. We may also need to consider pre-configured NCSG together with legacy MG, although we are still far from the mixed operation of three enhancements in this work item, we think it is still possible. If we are going to capture all the possible scenarios and configuration into the mechanism w.r.t. activation/deactivation of MG, we may end up with very complicated criteria in our spec.  To simply our specification, we prefer to let network control explicitly control whether MG should be ON or OFF. A simple way is to link the MG configuration to the BWP configuration. UE only needs to check if there is MG configured associated with the active BWP. If so then MG is ON, otherwise is OFF. On top of that RAN can further discuss some side condition for corresponding RRM requirements to avoid unexpected configuration. |
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**Issue 1-1-2 Whether shall the pre-configured MG when BWP switching on the multiple CCs be discussed?**

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| **Company** | **Comments** |
| MTK | Yes for CA only; but not for DC(Option 1d).   * In NR SA, it’s possible to ON/OFF preconfigured MG depends on MO configurations and BWP status. * In MR-DC, due to no dynamic coordination between MN and SN, the fast MG mechanism is not applied. |
| Apple | It is better to first align the understanding on mechanism of pre-configured MG.  For the use case, we think at least CA should be in the scope. Whether in MR-DC it can work depends on the mechanism. But of course it would be more challenging in MR-DC. |
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**Issue 1-1-3 Whether pre-configured MGs are applicable in MR-DC scenario**

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| **Company** | **Comments** |
| MTK | Option 2.  BWP switch is a L1 procedure.  From NW side, MN and SN cannot have timely communication for this L1 procedure.  From UE side, there is also no dynamic coordination on BWP switch between CGs. |
| Apple | We prefer to start from CA and deprioritize MR-DC scenario. |
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**Issue 1-1-4 Whether the pre-configured gaps shall be considered as a part of multiple concurrent gap patterns framework**

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| **Company** | **Comments** |
| MTK | Support option 1.  From our understanding, concurrent gaps is a powerful container. Both pre-configured gap and NCSG can be one of instance of concurrent gaps.  RAN4 can focus on separate topic in 1st stage, and discuss the combination in 2nd stage. (The 2 stage definition can be found in email thread [233] general issue 1-2) |
| Apple | Support option 1. We shall keep this in mind when discussing separate objective. |
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#### Sub-topic 1-2 Pre-configured MG activation/deactivation

**Issue 1-2-1 Pre-configured MG activation/deactivation mechanism**

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| **Company** | **Comments** |
| MTK | Option 1.  For DCI based BWP switch, the both NW and UE knows whether both current BWP and target BWP have SSB or not.  For Timer based BWP switch, the both NW and UE knows the timer and also whether the default BWP has SSB or not.  Thus, the MG ON/OFF mechanism can be implicitly triggered by NW with the BWP switch DCI command or Timer. |
| Apple | We can discuss this later once we reach consensus on issue 1-1-0. Even though many companies are listed behind option 1, we are not sure if all companies are on the same page. |
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**Issue 1-2-2 Issue 1-2-2 Evaluation on MG activation/deactivation mechanism**

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| **Company** | **Comments** |
| MTK | Due to implicitly triggered the MG ON/OFF by NW with the BWP switch DCI command or Timer, no new signaling is needed.  Not only the measurement gap configuration, but the data scheduling from NW will be error once UE can’t correctly switch the BWP, such as not decode the DCI correctly. When NW doesn’t receive the HARQ feedback in new BWP, NW will know the UE fails to decode the DCI.  All these evaluations had finished in BWP switch design from RAN1. RAN4 doesn’t need to evaluate the reliability of BWP switch again. |
| Apple | We support to let NW explicitly indicate whether and which MG to be used. Especially when pre-configured MG is considered together with multiple concurrent MG and NCSG. Such that NW and UE can have common understanding on the actual measurement period. |
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#### Sub-topic 1-3 RRM requirements

**Issue 1-3-1 Activation/Deactivation Delay**

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| **Company** | **Comments** |
| MTK | Support option 2.  BWP switch is a L1 procedure but MG activation is a L3 procedure. It may be a mismatch between these two procedures.  The detail ΔT can be further discussed. |
| Apple | According to our understanding of the procedure, some transition time may be needed. We prefer option 2. However, it may be challenging to reach consensus since companies may have different understanding on the mechanism. It is better to focus on mechanism first. |
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**Issue 1-3-2 Issue 1-3-2 Interruption requirements**

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| **Company** | **Comments** |
| MTK | No additional interruption requirement needed.  The interruption requirement had already defined in BWP switch.    To QC,  Not very clear the relation with NCSG, could QC further explain your option? |
| Apple | Our view is no further interruption is needed on top of the interruption caused by BWP switching. |
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**Issue 1-3-3 Issue 1-3-3 Measurement period**

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| **Company** | **Comments** |
| MTK | Depends on the discussion on issue 1-1-0.  When there is only one transition in the measurement period, the transition requirements in clause 9.1.6 can be applied.  When there is more than one transitions in the measurement period, the requirements are FFS. |
| Apple | It is better to discuss this after we have consensus on issue 1-1-0. |
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**Issue 1-3-4 Transitions between gapless and gap-based measurement procedures during ongoing measurements**

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| **Company** | **Comments** |
| MTK | Depends on the discussion on issue 1-1-0.  When there is only one transition in the measurement period, the transition requirements in clause 9.1.6 can be applied.  When there is more than one transitions in the measurement period, the requirements are FFS. |
| Apple | It is better to discuss this after we have consensus on issue 1-1-0. |
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**Issue 1-3-5 Whether there is scheduling restriction during pre-configured MGs when not used**

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| **Company** | **Comments** |
| MTK | Depends on the discussion on issue 1-1-0.  In NR SA,   * + if UE supports inter-frequency measurement without MG, and the SSB is completely contained in the active BWP or   + if there is intra-frequency MOs, and all of intra-frequencies’ active BWPs include SSB,   the fast MG can be OFF. The NW can schedule data in this time duration. |
| Apple | Prefer to discuss the scheduling restriction after we have clear design of pre-configured MG. |
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#### Sub-topic 1-4 MG pattern configurations

**Issue 1-4-1 Number of pre-configured MG patterns**

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| **Company** | **Comments** |
| MTK | Support option 3.  Pending on the discussion on issue 1-1-0.  RAN4 shall work on ON/OFF mechanism of fast MG other than how many number of pre-configured MG patterns. |
| Apple | Need further discussion. It is better to discuss this after we have consensus on issue 1-1-0. In our view, different MG pattern can be preconfigured for different BWP. Multiple MG patterns can be configured if we consider multiple concurrent MG. |
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**Issue 1-4-2 MG patterns used for the pre-configured MG mechanism**

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| **Company** | **Comments** |
| MTK | Pending on the discussion on issue 1-1-0.  RAN4 shall work on ON/OFF mechanism of fast MG other than pre-configured MG patterns. |
| Apple | Fine with option 1.  To MTK: could MTK clarify more on the comment? In our view pre-configured MG patterns is explicitly captured in the WID. |
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**Issue 1-4-3 Relation of pre-configured MG pattern and with the current RRC configured MG**

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| **Company** | **Comments** |
| MTK | Pending on the discussion on issue 1-1-0.  RAN4 shall work on ON/OFF mechanism of fast MG other than multiple MG patterns. |
| Apple | We think it is a bit early to discuss such detail. |
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**Issue 1-4-4 Per-UE/Per-FR pre-configured MG pattern applicability**

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| **Company** | **Comments** |
| MTK | Pending on the discussion on issue 1-1-0.  RAN4 shall work on ON/OFF mechanism of fast MG other than per-UE/per-FR MG pattern. |
| Apple | We discuss this later once we have agreement on issue 1-1-0. |
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#### Sub-topic 1-5 MG pattern configurations

**Issue 1-5-1 Signaling to enable the pre-configured MGs**

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| **Company** | **Comments** |
| MTK | Option 1.  A new signaling to enable/disable preconfigured MG can be introduced in RAN2.  But no additional signaling is needed for MG activation/deactivation(ON/OFF). ON/OFF MG can be implicitly triggered by BWP switch. |
| Apple | We discuss this later once we have agreement on issue 1-1-0. |
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### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
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## Summary for 1st round

### Open issues

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|  | **Status summary** |
| **Issue#1-1-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-1-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-1-3** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-1-4** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-2-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-2-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-3-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-3-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-3-3** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-3-4** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-4-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-4-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-4-3** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-4-4** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#1-5-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
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## Discussion on 2nd round

Please only comment on topics that are selected for discussion in 2nd round.

## Summary on 2nd round

No further agreement was reached in the 2nd round.

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
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# Topic #2: Network Controlled Small Gap (NCSG)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2100223**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2100223.zip) On network controlled small gap | Apple | **Proposal 1: VIL, ML and VIPR in NR NCSG can be defined as:**   * **VIL1 is the visible interruption length before measurement. During VIL1 UE is not expected to transmit or receive any date on corresponding serving cell(s).** * **ML is the measurement length. During ML UE is expected to transmit and receive data on the corresponding serving cell(s).** * **VIL2 is the visible interruption length after measurement. During VIL2 UE is not expected to transmit or receive any date on corresponding serving cell(s).** * **VIRP is the visible interruption repetition period.**   **Proposal 2: based on legacy R16 MG patterns, 26 NCSG patterns can be introduced with MGRP = VIRP and MGL = VIL1+ML+VIL2.**  **Proposal 3: for UE supporting per-FR gap, VIL is allowed only on the serving cell in the same FR wherein there is NCSG operation. Otherwise, VIL is allowed on all serving cells.**  **Proposal 4: switching time in VIL1 and VIL2 should be 0.5ms and 0.25ms for FR1 and FR2, respectively. Actual interruption length depends on VIL on aggressive cell and SCS of the victim cell.**  **Proposal 5: VIL1 = 1 slot in both DL and UL on synchronous victim cells in 15kHz. VIL1 = 2 slot in both DL and UL on asynchronous victim cells in 15kHz.**  **Proposal 6: for synchronous victim cells in 15kHz. VIL2 = 1 slot on DL and VIL2 = slots on UL. For asynchronous victim cells in 15kHz, one more slot interruption is allowed on VIL2 DL.**  **Proposal 7: VIL1 and VIL2 on UL are one more slot longer than that on DL for 30kHz, 60kHz and 120kHz in synchronous case.**  **Proposal 8: summary of VIL1 and VIL2:**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | (victim cell) | NR Slot length (ms) | VIL1 and VIL2 (slots) | | | |  | of victim cell | Sync | | Async | | 0 | 1 | VIL1 = (DL: 1 & UL: 1)  VIL2 = (DL: 1 & UL: 2) | | DL: 2  UL: 2 | | 1 | 0.5 | Aggressor cell is on FR1 | DL: 1  UL: 2 | DL: 2  UL: 2 | | Aggressor cell is on FR2 | VIL1 = (DL: 1 & UL: 1)  VIL2 = (DL: 1 & UL: 2) | DL: 2  UL: 2 | | 2 | 0.25 | Aggressor cell is on FR1 | DL: 2  UL: 3 | DL: 3  UL: 3 | |  |  | Aggressor cell is on FR2 | DL: 1  UL: 2 | DL: 2  UL: 2 | | 3 | 0.125 | Aggressor cell is on FR1 | DL: 4  UL: 5 | DL: 5  UL: 5 | |  |  | Aggressor cell is on FR2 | DL: 2  UL: 3 | DL: 3  UL: 3 |   **Proposal 9: signalling structure of NeedForGap in R16 can be used as baseline when discussing the support of NCSG.** |
| [**R4-2100456**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2100456.zip) Initial discussion on Network Controlled Small Gap (NCSG) | CATT | **Proposal 1: The same approach as LTE for NCSG can be reused in NR for both FR1 and FR2.**  **Proposal 2: Introduce the following NCSG pattern for gap pattern #24 and #25.**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | NCSG Pattern Id | Visible interruption length before measurement (VIL1, ms) | Measurement Length during which there is no gap (ML, ms) | Visible interruption length after measurement (VIL2, ms) | Visible interruption Repetition Period  (VIRP, ms) | Purpose | | 4 | 1 | 8 | DL: 1  UL: 2 | 80 | Interruption control according to requirements in sections 8.2.2.2.3 | | 5 | 1 | 8 | DL: 1  UL: 2 | 160 | Interruption control according to requirements in sections 8.2.2.2.3 | | 6 | 2 | 7 | 2 | 80 | Interruption control according to requirements in sections 8.2.2.2.3 | | 7 | 2 | 7 | 2 | 160 | Interruption control according to requirements in sections 8.2.2.2.3 |   **Proposal 3: Introduce the NCSG pattern in [4] to NR.** |
| [**R4-2100460**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2100460.zip) CR on NCSG in 38.133 | CATT | CR |
| [**R4-2101064**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101064.zip) Network Controlled Small Gap | MediaTek inc. | ***Proposal 1: Intra-frequency measurements with MG, inter-frequency measurements with MG or Inter-RAT measurements may use NCSG instead of MG when UE supports related band combination and have additional RF chains during the measurements***  *Observation 1: In Rel-16 NeedForGap’ mechanism, there is an ambiguity left that with ‘no gap’ UE is still allowed to cause interruptions or not.*  ***Proposal 2: Rel-17 NCSG to directly reuse Rel-16 ‘NeedForGap’ signalling with ‘no gap’ equalling NCSG.***  ***Proposal 3: The NR gap patterns #0~23 can be used to NCSG pattern and gap patterns #24 and #25 won’t apply to NCSG.***  ***Proposal 4: Both VIL length before and after measurements can be 0.5ms for per-UE gap and FR1 gap. Both VIL length before and after measurements can be 0.25ms for FR2 gap.***  ***Proposal 5: For NCSG, the requirements related to MGTA and impact to UL transmission follow Rel-15.***  ***Proposal 6: For NCSG, the VIRP is the same as MGRP in Rel-15.***  ***Proposal 7: The overall interrupted slots (before and after ML) is 3 for asynchronous operation when victim cell’s SCS=15KHz and VIL=0.5ms in FR1.***  ***Proposal 8: UE is not expected to measure 2 inter-freq/RAT layers in parallel even if UE reports the support of NCSG to both corresponding bands.***  ***Proposal 9: For FR2 intra-band or inter-band with CBM, UE can’t receive data or perform L1 or L3 measurements simultaneously with inter-frequency L3 measurement even if UE claims NCSG for these bands.***  ***Proposal 10: Due to no searcher limitation, when UE performs intra-frequency measurements for PCell and one SCell. FFS whether an additional inter-RAT measurement for NCSG band can also be performed in parallel.*** |
| [**R4-2101271**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101271.zip) Discussion on NCSG in NR | Intel Corporation | ***Proposal 1****:* ***Similar as in LTE, RAN4 can prioritize the following NR NCSG using scenario****:*   * + - ***Eliminate/reduce interruptions to the serving carriers due to RF chain states transition when measuring the deactivated SCells***   ***Proposal 2: In order to minimize RAN4 and other RAN group’s standardization efforts, RAN4 can define NR NCSG patterns based on existing NR legacy MG patterns in [2].***  ***Proposal 3: The interruption requirements during measurements on SCC defined in TS38.133 and TS36.133 shall be revisited because of NCSG is used.***  ***Proposal 4*: *The “NeefForGap” signaling structure can be reused for NR NCSG as a start point.*** |
| [**R4-2101382**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101382.zip) Considerations on network controlled small gap | vivo | **Observation: NCSG could provide more benefit on top of inter frequency measurement without gap feature. On the other hand, the benefit may be reduced when the SMTC window of different inter-frequency layers are not aligned.**  **Proposal 1: For one particular NCSG gap pattern designed for Rel-17, initially only consider the structure where one gap pattern consists of VIL1, ML, VIL2 and VIRP.**  **Proposal 2: The complexity caused by introducing extra NCSG patterns should be carefully studied as well during the WI period**  **Proposal 3: whether to introduce NCSG pattern for each already defined gap pattern or not needs investigation** |
| [**R4-2101539**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2101539.zip) Views on pre-configured MG pattern(s) for NR\_MG\_enh | OPPO | **Observation 1: The design of NCSG including VIL, ML and VIRP can be based on the methods for LTE.**  **Proposal 1: Reuse the LTE values of VIL for NR.**  **Proposal 2: NCSG for NR should be defined for the measurements with long MGL, e.g., 6ms for FR1 or 5.5ms FR2.**  **Proposal 3: The VIRP of NCSG should refer to the MGRP of NR measurement gap, including 20, 40, 80, 160 ms.**  **Proposal 4: During the VIL1 and VIL2, the UE is not expected to transmit and receive any data. UE shall not make any autonomous interruption outside the visual interruption (VIL) of the configured NCSG for the measurement**  **Proposal 5: During ML, the UE is expected to transmit and receive data on the corresponding serving carrier, where measurement is allowed.**  **Proposal 6: Define NCSG configuration for NR with a fixed length (ms) of VIL and ML as Table 2.**  Table 2: NCSG configuration for NR   |  |  |  |  |  | | --- | --- | --- | --- | --- | | NCSG Pattern Id | Visible interruption length before measurement (VIL1, ms) | Measurement Length during which there is no gap (ML, ms) | Visible interruption length after measurement (VIL2, ms) | Visible interruption Repetition Period  (VIRP, ms) | | 0 | 1 | 4 | DL: 1  UL: 2 | 40 | | 1 | 1 | 4 | DL: 1  UL: 2 | 80 | | 2 | 2 | 3 | 2 | 40 | | 3 | 2 | 3 | 2 | 80 | | 4 | 1 | 4 | DL: 1  UL: 2 | 20 | | 5 | 1 | 4 | DL: 1  UL: 2 | 160 | | 6 | 2 | 3 | 2 | 20 | | 7 | 2 | 3 | 2 | 160 | | 8 | 1 | 3.5 | DL: 1  UL: 2 | 40 | | 9 | 1 | 3.5 | DL: 1  UL: 2 | 80 | | 10 | 2 | 2.5 | 2 | 40 | | 11 | 2 | 2.5 | 2 | 80 | | 12 | 1 | 3.5 | DL: 1  UL: 2 | 20 | | 13 | 1 | 3.5 | DL: 1  UL: 2 | 160 | | 14 | 2 | 2.5 | 2 | 20 | | 15 | 2 | 2.5 | 2 | 160 |   **Proposal 7: NCSG pattern should be configured based on MG configuration considering per FR1 or FR2 gap.** |
| [**R4-2102611**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102611.zip) Discussion on network controlled small gap | Qualcomm CDMA Technologies | **Observation1**: Choice of LTE NCSG patterns depends on whether UE is configured  **Observation2**: use cases of NCSG can be two scenarios,   1. When measurement gap is not configured at all, NCSG can be explicitly provided to UE for minimal interruptions on a serving carrier while an idle chain is employed for measurement. 2. When measurement gap is configured for some carriers but not the others, NCSG can be implicitly configured on serving carriers, where the serving carrier can be PCC or SCC.\*   **Observation3**: NCSG is not applicable when measurement gap is configured on all the serving carriers including PCC and SCCs.  with asynchronous DC for PCELL and PSCELL.  **Proposal1: NR NCSG VIL1 may consider [1]ms for 15Khz SCS.**  **Proposal1.1: VIL1 can be longer as [2]ms and VIL2 can be [2]ms for NR 15Khz SCS.**  **Proposal1.2: choice of NR NCSG ML shall consider configured MGL such that VIL1+VIL2 < ML, where ML is the same as MGL by default.**  **Proposal2: UE may assume the implicit and explicit configurations of NCSG are not concurrently activated.**  **Proposal2.1: Implicit activation of NCSG means UE may introduce VILs at the start and stop of a configured MG while ML is the same as MGL and VIRP is the same as MGRP.**  **Proposal2.2: Explicit activation of NCSG means UE follows the configuration of the network in terms of VIL1/VIL2/ML and VIRP.**  **Proposal3: UE capabilities for supporting per UE based NCSG and/or per FR based NCSG shall be introduced instead of overloading the existing per FR/per UE MG UE capability.**  **Proposal3.1: In NR CA/DC, when NCSG is enabled, VIL interruptions can take place on serving carriers if their active BWPs donot cover the target raster point and a spare RF chain is available for measuring the target frequency**.  **Proposal3.2: in ENDC or NEDC, when per UE based NCSG is configured, it is expected to follow the same NCSG pattern for both LTE and NR, i.e. NR NCSG pattern shall be aligned with the LTE NCSG pattern.**  **Proposal4: Similar section for defining NCSG patterns can be introduced in the 38.133 section 9.1.2 Measurement capability.**  **Proposal4.1: Impacts of supporting NCSG include the interruptions on PCELL, PSCELL and/or other activated SCELLs shall be properly captured in 38.133 section8.2 for interruptions when running measurements for NRCA, NRDC, ENDC, NEDC and RSTD measurements.**  **Proposal4.2: RAN4 to address how to capture the NCSG resulted interruptions in addition to the signal characteristics requirements on interruption in the existing spec.** |
| [**R4-2102656**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102656.zip) Overview of requirements for network controlled small gap | Ericsson | * **Proposal # 1**: If NCSG is configured then the interruptions on PCell, PSCell or activated SCell(s) due to measurements on PCell, PSCell, activated SCell, deactivated SCell, SCell with dormant BWP or unused RF chain shall not occur outside the visible interruption length before measurement (VIL1) and the visible interruption length after measurement (VIL2). * **Proposal # 2**: If NCSG is pre-configured then after switching from non-dormant BWP to dormant BWP on a SCell, then interruptions on PCell, PSCell or activated SCell(s) due to measurements on the SCell with dormant BWP shall not occur outside the visible interruption length before measurement (VIL1) and the visible interruption length after measurement (VIL2). * **Proposal # 3**: For UE capable of per UE gaps, NCSG pattern can be configured to avoid intterruptions provided that the UE is not configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133. * **Proposal # 4**: For UE capable of per FR gaps:   + NCSG pattern cannot be configured in parallel with any legacy gap pattern (defined in Table 9.1.2-1, TS 38.133) on the same FR.   + NCSG pattern can be configured on an FR to avoid intterruptions provided that on the same FR the UE is not configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133. * **Proposal # 5:** If UE capable of NCSG and per UE gaps is configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133 and there is no inter-frequency or inter-RAT carrier to monitor, then the UE shall not cause any interruption PCell, PSCell or activated SCells due to measurements on PCell, PSCell or SCells. * **Proposal # 6:** If UE capable of NCSG and per FR gaps is configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133 on an FR and there is no inter-frequency or inter-RAT carrier to monitor on that FR, then the UE shall not cause any interruption PCell, PSCell or activated SCells on that FR due to measurements on PCell, PSCell or SCells of that FR. * **Proposal # 7**: Define separate NCSG patterns for synchronous and asynchronous MR-DC. * **Proposal # 8**: Define NCSG patterns for synchronous and asynchronous MR-DC corresponding to legacy gap patterns with ID # 0 to ID #23 (defined in Table 9.1.2-1, TS 38.133). * **Proposal # 9**: VIL1 and VIL2 for FR1 and FR2 are defined as follows:  |  |  |  |  | | --- | --- | --- | --- | | **VIL1** | | **VIL2** | | | **Sync** | **Async** | **Sync** | **Async** | | 1 ms | 2 ms | 1 ms | 2 ms | | 0.75 ms | | 0.75 ms | |  * **Proposal # 10:** ML for synchronous MR-DC (MLsync) and ML for aynchronous MR-DC (MLasync) can be derived as follows:   MLsync = Nslots\_sync ×Tslot - (VIL1+VIL2) [ms]  MLasync = Nslots\_async ×Tslot - (VIL1+VIL2) [ms]  Where:   * + Nslots\_sync = Total number of interrupted slots on serving cells defined in Table 9.1.2-4, TS 38.133.   + Nslots\_async = Total number of interrupted slots on serving cells defined in Table 9.1.2-4a, TS 38.133.   + Tslot = NR slot length in ms * **Proposal # 11**: Measurement period for measurement done on cells of a carrier when NCSG pattern is used or legacy gap pattern is used for avoiding interruption will depend on and scale with the gap periodicity of the corresponding NCSG pattern or legacy gap pattern |
| [**R4-2102689**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102689.zip) On Introduction of Network Controlled Small Gaps for NR | Nokia, Nokia Shanghai Bell | 1. Feedback on RF tuning times in FR1 and FR2 should be acquired from UE RF subgroup. Existing interruption requirements for SCell activation/deactivation can serve as starting point for the study of VIL requirements. 2. For ML requirements, RAN4 should align to specified measurement gap lengths in TS 38.133 and study even longer measurement durations. 3. RAN4 should specify NCSG patterns for synchronous NR SA / MR-DC and asynchronous NR SA / MR-DC operation and assign higher priority to synchronous NR SA / MR-DC operation. 4. RAN4 should consider defining a limited number of suitable NCSG patterns and assign a UE capability to some of them, while the remaining ones will form a basic set. In addition, RAN4 may consider a UE capability in view of different support levels related to VIL requirements. |
| [**R4-2102812**](file:///C:\Users\rhuang5\OneDrive%20-%20Intel%20Corporation\Documents\my_work\LTE_A\RAN4\98e\Docs\R4-2102812.zip) Initial discussion on NCSG | Huawei, HiSilicon | **Proposal 1: Support per UE and per FR NCSG for RRM measurement based on UE capability reporting.**  **Proposal 2: Define same VIL for UL and DL. UE UL transmission behaviour after VIL1 and VIL2 is same as that after MG.**  **Proposal 3: Define same VIL for sync and async DC cases. Slots that overlap with VIL is considered as interrupted, and UE is required to receive and transmit in all the other slots including the ML (except UL slots after VIL).**  **Proposal 4: Define an NCSG pattern for each of the MG pattern #0-23, where**   * **VIRP is same as the corresponding MGRP** * **VIL is 0.5ms if it corresponds to MG pattern #0-11, and 0.25ms for MG pattern #12-23** * **ML is the corresponding MGL excluding VIL1 and VIL2**   **Proposal 5: Further discuss two options for measurement during ML**   * **Option 1: UE only performs measurement that requires NCSG** * **Option 2: UE performs both measurement that requires NCSG and measurement that does not require NCSG or MG** |

## Open issues summary

NCSG of this WI are as follows:

* + *Network Controlled Small Gap (NCSG) specification [RAN4, RAN2]*
    - *RRM requirements for NCSG [RAN4]*
      * *Requirements for Visible Interruption Length (VIL) for different numerologies in FR1 and FR2*
      * *Specification of NCSG patterns, Measurement Length (ML), and Visible Interruption Repetition Period (VIRP)*
      * *Requirements for DL reception and UL transmission during ML, before start VIL and after end VIL*
      * *Measurement requirements with NCSG*
    - *Specification of applicability of NCSG patterns [RAN4]*
    - *Procedures and signaling for NCSG patterns [RAN2]*

### Sub-topic 2-1 Scenarios and use cases

#### **Issue 2-1-1 NCSG scenarios**

* Option 1 (Intel): RAN4 can prioritize the following NR NCSG using scenario: Eliminate/reduce interruptions to the serving carriers due to RF chain states transition when measuring the deactivated SCells
* Option 1a (Qualcomm): use cases of NCSG can be two scenarios,
  + When measurement gap is not configured at all, NCSG can be explicitly provided to UE for minimal interruptions on a serving carrier while an idle chain is employed for measurement.
  + When measurement gap is configured for some carriers but not the others, NCSG can be implicitly configured on serving carriers, where the serving carrier can be PCC or SCC.
* Option 1b (Ericsson):
  + Case 1: If NCSG is configured then the interruptions on PCell, PSCell or activated SCell(s) due to measurements on PCell, PSCell, activated SCell, deactivated SCell, SCell with dormant BWP or unused RF chain shall not occur outside the visible interruption length before measurement (VIL1) and the visible interruption length after measurement (VIL2).
  + Case 2: If NCSG is pre-configured then after switching from non-dormant BWP to dormant BWP on a SCell, then interruptions on PCell, PSCell or activated SCell(s) due to measurements on the SCell with dormant BWP shall not occur outside the visible interruption length before measurement (VIL1) and the visible interruption length after measurement (VIL2).
  + Case 3: For UE capable of per UE gaps, NCSG pattern can be configured to avoid interruptions provided that the UE is not configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133.
  + Case 4: For UE capable of per FR gaps:
    - NCSG pattern cannot be configured in parallel with any legacy gap pattern (defined in Table 9.1.2-1, TS 38.133) on the same FR.
    - NCSG pattern can be configured on an FR to avoid interruptions provided that on the same FR the UE is not configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133.
  + Case 5: If UE capable of NCSG and per UE gaps is configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133 and there is no inter-frequency or inter-RAT carrier to monitor, then the UE shall not cause any interruption PCell, PSCell or activated SCells due to measurements on PCell, PSCell or SCells.
  + Case 6: If UE capable of NCSG and per FR gaps is configured with any legacy gap pattern defined in Table 9.1.2-1, TS 38.133 on an FR and there is no inter-frequency or inter-RAT carrier to monitor on that FR, then the UE shall not cause any interruption PCell, PSCell or activated SCells on that FR due to measurements on PCell, PSCell or SCells of that FR.
* Option 2. (MTK): Intra-frequency measurements with MG, inter-frequency measurements with MG or Inter-RAT measurements may use NCSG instead of MG when UE supports related band combination and have additional RF chains during the measurements
* Option 3. (Huawei): Support per UE and per FR NCSG for RRM measurement based on UE capability reporting (e.g. extension to Rel-16 NeedForGap signaling).

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-1-2 NCSG for synchronous/asynchronous operation**

* Option 1. (Nokia, Intel, Ericsson, Apple): NCSG patterns shall be defined for both synchronous and asynchronous operations

Recommended WF: Agree Option 1.

### Sub-topic 2-2 UE behavior within NCSG

#### **Issue 2-2-1 UE behvior during VIL, ML**

* Option 1 (Apple, OPPO): same as UE within LTE NCSG, that is
  + During VIL1/VIL2 UE is not expected to transmit or receive any date on corresponding serving cell(s).
  + During ML UE is expected to transmit and receive data on the corresponding serving cell(s).

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 2-3 NCSG pattern

#### **Issue 2-3-1 General NCSG pattern design principle**

* Option 1a (CATT) The same approach as LTE for NCSG can be reused in NR for both FR1 and FR2. And the new NCSG pattern for gap pattern #24 and #25 are introduced.
* Option 1b (Apple): Based on legacy R16 MG patterns, 26 NCSG patterns can be introduced with MGRP = VIRP and MGL = VIL1+ML+VIL2
* Option 2 (Intel) reuse part of the legacy MG patterns in [2] as the new NCSG patterns in NR.
  + Option 2a (OPPO): reuse part of the legacy MG patterns with long MGL, e.g., gap pattern with ID 0,1,4,5 for FR1, or ID 12,13,14,15 for FR2.
  + Option 2b (MTK) The NR gap patterns #0~23 can be used to NCSG pattern and gap patterns #24 and #25 won’t apply to NCSG.
* Option 3 (Ericsson, Huawei) Define NCSG patterns for synchronous and asynchronous MR-DC corresponding to legacy gap patterns with ID # 0 to ID #23 (defined in Table 9.1.2-1, TS 38.133).

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-3-2 Visible Interruption Length (VIL)**

* Option 1 (Apple): VIL1&2 is the visible interruption length before measurement.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| (victim cell) | NR Slot length (ms) | VIL1 and VIL2 (slots) | | |
|  | of victim cell | Sync | | Async |
| 0 | 1 | VIL1 = (DL: 1 & UL: 1)  VIL2 = (DL: 1 & UL: 2) | | DL: 2  UL: 2 |
| 1 | 0.5 | Aggressor cell is on FR1 | DL: 1  UL: 2 | DL: 2  UL: 2 |
| Aggressor cell is on FR2 | VIL1 = (DL: 1 & UL: 1)  VIL2 = (DL: 1 & UL: 2) | DL: 2  UL: 2 |
| 2 | 0.25 | Aggressor cell is on FR1 | DL: 2  UL: 3 | DL: 3  UL: 3 |
|  |  | Aggressor cell is on FR2 | DL: 1  UL: 2 | DL: 2  UL: 2 |
| 3 | 0.125 | Aggressor cell is on FR1 | DL: 4  UL: 5 | DL: 5  UL: 5 |
|  |  | Aggressor cell is on FR2 | DL: 2  UL: 3 | DL: 3  UL: 3 |

* Option 2 (MTK): Both VIL length before and after measurements can be 0.5ms for per-UE gap and FR1 gap. Both VIL length before and after measurements can be 0.25ms for FR2 gap.

|  |  |  |
| --- | --- | --- |
|  | **VIL in Sync (ms)** | **VIL in Async(ms)** |
| **FR1** | 0.5 | |
| **FR2** | 0.25 | |
| Note: Interruption slots can be different for sync. and async. | | |

* Option 3 (Intel):

|  |  |  |
| --- | --- | --- |
|  | **VIL in Sync (ms)** | **VIL in Async(ms)** |
| **FR1** | 1 | 2 |
| **FR2** | 0.75 | |

* Option 4 (Qualcomm):
  + NR NCSG VIL1 may consider [1,2]ms for 15Khz SCS and VIL2 can be [2]ms for NR 15Khz SCS.
* Option 5 (Ericsson):
  + VIL1 and VIL2 for FR1 and FR2 are defined as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| **VIL1** | | **VIL2** | |
| **Sync** | **Async** | **Sync** | **Async** |
| 1 ms | 2 ms | 1 ms | 2 ms |
| 0.75 ms | | 0.75 ms | |

* Option 6 (OPPO): same as LTE’s VIL
* Option 7 (Huawei):
  + VIL1=VIL2, UE UL transmission behaviour after VIL1 and VIL2 is same as that after MG.
  + Define same VIL for sync and async DC cases. Slots that overlap with VIL is considered as interrupted, and UE is required to receive and transmit in all the other slots including the ML (except UL slots after VIL).
  + VIL is 0.5ms if it corresponds to MG pattern #0-11, and 0.25ms for MG pattern #12-23
* Option 8 (Nokia):
  + For study of VIL requirements, feedback on RF tuning times in FR1 and FR2 should be acquired from UE RF subgroup.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-3-3 Measurement Length (ML)**

* Option 1. (Apple, Huawei): based on MGL of the legacy R16 MG patterns (#0-25), MGL = VIL1+ML+VIL2.
* Option 2a (Intel, MTK, Huawei): ML can be defined based on NR legacy gap patterns [2, TS38.133] but some of them could be excluded (e.g. #24, 25).
* Option 2b(Qualcomm): choice of NR NCSG ML shall consider configured MGL such that VIL1+VIL2 < ML, where ML is the same as MGL by default
* Option 2 (Ericsson): ML for synchronous MR-DC (MLsync) and ML for aynchronous MR-DC (MLasync) can be derived as follows:

MLsync = Nslots\_sync ×Tslot - (VIL1+VIL2) [ms]

MLasync = Nslots\_async ×Tslot - (VIL1+VIL2) [ms]

Where:

* + Nslots\_sync = Total number of interrupted slots on serving cells defined in Table 9.1.2-4, TS 38.133.
  + Nslots\_async = Total number of interrupted slots on serving cells defined in Table 9.1.2-4a, TS 38.133.
  + Tslot = NR slot length in ms
* Option 3a (OPPO): NCSG for NR should be defined for the measurements with long MGL, e.g., 6ms for FR1 or 5.5ms FR2
* Option 3b (Nokia) ML can be based on MGL in TS38.133 and study longer ones

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-3-4 Visible Interruption Repetition Period (VIRP)**

* Option 1. (Apple, Intel, Huawei, OPPO, MTK):VIRP = MGRP of legacy MG
* Option 1a (Intel): Reuse some of the legacy MG patterns with longer MGRP(>20ms) in [2] as the new NCSG patterns in NR.

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 2-4 Configuration of NCSG

#### **Issue 2-4-1 Per-UE/Per-FR NCSG applicability**

* Option 1 (OPPO): NCSG pattern should be configured based on MG configuration considering per FR1 or FR2 gap.

Recommended WF: Further discussion needed. Collect companies’ views

#### **Issue 2-4-2 Implicit or explicit configuration of NCSG**

* Option 1. (Qualcomm): UE may assume the implicit and explicit configurations of NCSG are not concurrently activated.
  + Implicit activation of NCSG means UE may introduce VILs at the start and stop of a configured MG while ML is the same as MGL and VIRP is the same as MGRP.

*[Proponent Notes: implicit activation of NCSG does NOT require the network to indicate the pattern of NCSG in the RRC signaling. Rather, both NW and UE can assume NCSG on the serving carriers will align with the configured MG, i.e. ML==MGL, VIRP==MGRP, VIL1 and VIL2 are inherently determined to be 1ms (or 2ms)]*

* + Explicit activation of NCSG means UE follows the configuration of the network in terms of VIL1/VIL2/ML and VIRP.

*[Moderator Notes: Please the proponent of Option1 interpret more on the implicit configuration means]*

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 2-5 Measurement requirements impacts

#### **Issue 2-5-1 Interruption requirements**

* Option 1 (Intel, Qualcomm): The interruption requirements in TS38.133 and TS36.133 shall be revisited
* Option 1a. (Apple) for UE supporting per-FR gap, VIL is allowed only on the serving cell in the same FR wherein there is NCSG operation. Otherwise, VIL is allowed on all serving cells.
* Option 2(Nokia): Existing interruption requirements for SCell activation/deactivation can serve as starting point for the study of VIL requirements

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-5-2 Impacts on MGTA and UL transmission requirements**

* Option 1 (MTK): requirements related to MGTA and impact to UL transmission follow Rel-15.

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 2-6 Capability support

#### **Issue 2-6-1 Per-UE or Per-FR capability support**

* Option 1. (Qualcomm): per UE and per FR NCSG for RRM measurement needs the specific UE capability.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-6-2 Number of NSCG patterns configured**

* Option 1. (Nokia): RAN4 should consider defining a limited number of suitable NCSG patterns and assign a UE capability to some of them, while the remaining ones will form a basic set. In addition, RAN4 may consider a UE capability in view of different support levels related to VIL requirements

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 2-7 Applicability

#### **Issue 2-7-1 Measurement requirements applicability**

* Option 1 (Huawei) Further discuss the applicability for the two cases for measurement during ML
  + Case 1: UE only performs measurement that requires NCSG
  + Case 2: UE performs both measurement that requires NCSG and measurement that does not require NCSG or MG
* Option 2 (MTK) RAN4 to discuss the type of NCSG as follow.
  + Option 2-1: Reuse CSSFwithin\_gap

NW configures NCSG to replace legacy gap.

* + Option 2-2: Reuse CSSFwithout\_gap

NW configures NCSG simultaneously with legacy gap, and the frequencies of NCSG can be included in CSSFwithout\_gap similar as inter-frequency without gap.

* + Option 2-3: Introduce CSSFwithin\_NCSG

NW configures NCSG simultaneously with legacy gap, and NCSG can be believed as a new type of gap.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-7-2 RF combination limitation**

* Option 1. (MTK): UE is not expected to measure 2 inter-freq/RAT layers in parallel even if UE reports the support of NCSG to both corresponding bands.
* Option 2 (Qualcomm): NCSG is not applicable when measurement gap is configured on all the serving carriers including PCC and SCCs.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-7-3 Rx beam limitation**

* Option 1. (MTK): For FR2 intra-band or inter-band with CBM, UE can’t receive data or perform L1 or L3 measurements simultaneously with inter-frequency L3 measurement even if UE claims NCSG for these bands.

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-7-4 Searcher limitation**

* Option 1 (MTK): Due to no searcher limitation, when UE performs intra-frequency measurements for PCell and one SCell. FFS whether an additional inter-RAT measurement for NCSG band can also be performed in parallel

Recommended WF: Further discussion needed. Collect companies’ views.

#### **Issue 2-7-5 Scheduling and measurement restriction**

* Option 1 (MTK): RAN4 needs to further investigate the scheduling and measurement restriction between serving cell L1 measurement, intra-frequency measurements and inter-frequency measurements for NCSG,

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 2-8 Specification structure

#### **Issue 2-8-1 Which clause can be used to include NCSG pattern in 38.133**

* Option 1 (Qualcomm): Similar section for defining NCSG patterns can be introduced in the 38.133 section 9.1.2 Measurement capability.

Recommended WF: Further discussion needed. Collect companies’ views.

### Sub-topic 2-9 Relation with ‘NeedForGap’

**Issue 2-9-1 How to consider the relation between NCSG and ‘NeedForGap’?**

* Option 1 (MTK): Rel-17 NCSG to directly reuse Rel-16 ‘NeedForGap’ signalling with ‘no gap’ equalling NCSG.
* Option 2 (Intel): The “NeefForGap” signaling structure can be reused for NR NCSG as a start point

Recommended WF: Further discussion needed. Collect companies’ views.

## Companies views’ collection for 1st round

### Open issues

#### Sub-topic 2-1 Using scenarios of Pre-configured measurement gap

**Issue 2-1-1 NCSG Scenarios**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MTK | Option 2.  In legacy LTE, the possible use cases for NCSG are as follow,   * Enable measurement on unused RF chains with interruption controlled on activated CC * Enable per-CC measurement gap configuration with interruption controlled * Eliminate/reduce interruption rate due to deactivated SCell measurement   Due to no per-CC gap in NR, only bullet 1 and 3 can be applied for NR.  For bullet 1 in NR,  Intra-frequency measurements with MG, inter-frequency measurements with MG or Inter-RAT measurements may use NCSG instead of MG when UE supports related band combination and have additional RF chains during the measurements.  For option 3,  NCSG can directly reuse NeedForGap signalling in Rel-16 with further clarification. |
| Apple | Seems these options do not completely conflict with each other. On top of these, we would like to mention another use case: when UE is to measure an intra-band target cell, it is sometimes feasible for UE to enlarge BW of the RF chain to cover target SSB. With this assumption, even if there is no spare RF chain, UE may still be able to support NCSG based measurement. Overall the support of NCSG highly depends on UE architecture and band-combination being used. From this perspective, different interruption requirement for NCSG may be defined for UE support per UE and per FR gap. However, the support of NCSG can be based on NeedForGap signaling structure. |
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**Issue 2-1-2 NCSG for synchronous/asynchronous operation**

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| **Company** | **Comments** |
| MTK | Not support option 1.  Obviously, NCSG can be applied for both sync and async. scenario.  However, due to numerology, MGTA, different UL behaviour introducing in NR, NCSG pattern design in NR shall be different with LTE. NCSG pattern can be defined based on absolute RF retuning time + ML. The total interruption slots due to numerology, sync/async, MGTA can be captured in another table similar as legacy NR measurement gap. |
| Apple | Design of VIL and ML may be different in sync and async scenario. However, we still think it is feasible to define NCSG for async scenario. Even though the ML in async case may be smaller, it is still better than legacy MG. |
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#### Sub-topic 2-2 UE behavior within NCSG

**Issue 2-2-1 UE behavior during VIL, ML**

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| **Company** | **Comments** |
| MTK | RAN4 shall clarify VIL definition before the discussion.   * During both VIL1/VIL2 and related interruption slots, UE is not expected to transmit or receive any date on corresponding serving cell(s). * During ML UE is expected to transmit and receive data on the corresponding serving cell(s). |
| Apple | Support option 1. Open to further discussion. |
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#### Sub-topic 2-3 NCSG pattern

**Issue 2-3-1 General NCSG design principle**

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| **Company** | **Comments** |
| MTK | Option 2b.  To simplify the design, the first 24 NR gap patterns (#0~23) can be reused for NCSG gap patterns. However, the intention of introducing #24 and #25 in legacy NR is to allow UE to skip data RX/Tx, which contradicts to the concept of NCSG. Thus, gap pattern #24 and #25 won’t apply to NCSG. |
| Apple | Fine with either option 1b or 2b. If there is no further enhancement in PRS measurement, we agree that #24 and #25 don’t have to be included. Technically, we think it is feasible. |
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**Issue 2-3-2 Visible Interruption Length (VIL)**

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| **Company** | **Comments** |
| MTK | Option 2.  RAN4 shall firstly discuss how to capture the interruption slots length for NCSG in NR. There are two options:   1. Option 1: Capture the interruption slots in NCSG pattern directly 2. Option 2: Capture the interruption slots separately with NCSG pattern   We know in LTE the interruption slots was captured directly in NCSG pattern, but in NR, due to numerology, MGTA, sync/async, UL slots impact, if we capture the interruption slots in NCSG pattern directly, the patterns will be too complexity once all these factors will be considered.  At the same time, in legacy NR R-15, the interruption slots had already defined separately Table 9.1.2-4, 4a, 4b.  Thus, we suggest to follow NR R-15 rule to define the VIL based on absolute RF retuning time and define the interruption slots separately. We suggest to change the VIL naming to RRT (RF retuning time).  RRT(RF retuning time) can be 0.5ms for FR1 and 0.25ms for FR2 aligning with Rel-15 spec. |
| Apple | We think RAN4 should first try to reach consensus on RF switching time in NCSG operation. Then whether and how to translate switching time into number of slot can be further discussed.  In our calculation, we assume 0.5ms and 0.25ms switching time respectively for FR1 and FR2, which is same as R15 assumption according 38.133.  When translating absolute switching time into number of victim slots, we would like to highlight that sometimes VIL1 ≠ VIL2 due to several aspects, such as sync/async, MRTD/MTTD, TA in UL and so on. |
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**Issue 2-3-3 Measurement length (ML)**

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| **Company** | **Comments** |
| MTK | Support option 1 and 2.  As we mentioned before, it’s better to define VIL based on absolute RF retuning time(RRT). Thus, MGL = VIL1 + VIL2 + ML.  Option 2 is another issue. It’s the same as issue 2-3-1.  To simplify the design, the first 24 NR gap patterns (#0~23) can be reused for NCSG gap patterns. However, the intention of introducing #24 and #25 in legacy NR is to allow UE to skip data RX/Tx, which contradicts to the concept of NCSG. Thus, gap pattern #24 and #25 won’t apply to NCSG. |
| Apple | Support option 1. |
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**Issue 2-3-4 VIRP**

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| **Company** | **Comments** |
| MTK | Option 1 |
| Apple | Support option 1. |
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#### Sub-topic 2-3 Configuration of NCSG

**Issue 2-4-1 Per-UE/Per-FR NCSG applicability**

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| **Company** | **Comments** |
| MTK | Option 1 |
| Apple | Not sure if we clearly understand option 1. Does it mean we only consider per FR1 or per FR2 NCSG? In our understanding for UE which doesn’t support per-FR gap, if NCSG is configured, interruption should be allowed for all serving cell across both FR1 and FR2. |
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**Issue 2-4-2 Implicit or explicit configuration of NCSG**

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| **Company** | **Comments** |
| MTK | RAN4 needs further discussion this issue.  We would like to provide the views for configuration of NCSG.   * When UE reports to support NCSG, the same NCSG patterns can be implicitly supported by UE when UE reports the supported MG patterns. * After that, the NCSG capability reporting can be same as the NeedForGap reporting. UE can dynamically reports which band combination to support NCSG depending on current CA status. * Finally, the NW can configures the NCSG VIRP/VIL/offset similar as MG configuration explicitly.   In Rel-16, UE can reports whether it supports ‘no gap’ for a target band under current CA band combinations. When NCSG is introduced, we can re-use this NeedForGap reporting for NCSG and further clarify ‘no gap’ means ‘NCSG’ with interruption. |
| Apple | In our view the support of NCSG highly depends on UE architecture and band-combination being used. It is better to follow explicit configuration from network such as UE and NW can have common understanding whether UE can be scheduled during ML. |
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#### Sub-topic 2-5 Measurement requirements impacts

**Issue 2-5-1 Interruption requirements**

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| **Company** | **Comments** |
| MTK | Support option 1 and 1a. The interruption shall only depend on VIL length. For example,  Table 1. Total number of interrupted slots on all serving cells for synchronous operation with per-UE measurement gap or per-FR measurement gap   |  |  |  | | --- | --- | --- | | NR | Total number of interrupted slots on serving cells | | | SCS | When MG timing advance of 0ms is applied, VIL=0.5ms | When MG timing advance of 0.5ms is applied, VIL=0.5ms | | (kHz) | | 15 | 1 | 1 | | 30 | 1 | 1 | | 60 | 2 | 2 | | 120 | 4 | 4 |   Table 2. Total number of interrupted slots on all serving cells for asynchronous operation with per-UE measurement gap or per-FR measurement gap   |  |  |  |  |  | | --- | --- | --- | --- | --- | | NR | Total number of interrupted slots on serving cells | | | | | SCS | When MG timing advance of 0ms is applied | | When MG timing advance of 0.5ms is applied | | | (kHz) | VIL1=0.5ms | VIL2=0.5ms | VIL1=0.5ms | VIL2=0.5ms | | 15 | 2 or 1 Note 3 | 1 or 2 Note 3 | 2 or 1 Note 3 | 1 or 2 Note 3 | | 30 | 2 | 2 | 2 | 2 | | 60 | 3 | 3 | 3 | 3 | | 120 | 5 | 5 | 4 | 5 | | NOTE 3: The numbers of interrupted slots for VIL1 and VIL2 should not be the same. | | | | |   Table 3. Total number of interrupted slots on FR2 serving cells with per-FR measurement gap for FR2   |  |  |  | | --- | --- | --- | | NR  SCS  (kHz) | Total number of interrupted slots on FR2 serving cells | | | When MG timing advance of 0ms is applied, VIL=0.25ms | When MG timing advance of 0.25ms is applied, VIL=0.25ms | | 60 | 1 | 1 | | 120 | 2 | 2 | |
| Apple | Support option 1 and 1a. better to focus on 2-3-2 first. |
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**Issue 2-5-2 Impacts on MGTA and UL transmission requirements**

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| **Company** | **Comments** |
| MTK | Option 1.  To simplify the discussion, NCSG shall follow the same rule MG design in Rel-15 on MGTA and UL impact. |
| Apple | In general option 1 looks good. |
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#### Sub-topic 2-6 Capability support

**Issue 2-6-1 Per-UE or Per-FR capability support**

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| **Company** | **Comments** |
| MTK | Not support.  No new capability for per-UE/per-FR is needed. It can follow legacy MG capability. |
| Apple | We don’t think new capability is needed. |
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**Issue 2-6-2 Number of NSCG patterns configured**

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| **Company** | **Comments** |
| MTK | We think this is the same issue as 2-3-1.  From our understanding, when UE reports to support NCSG, the same NCSG pattern index can be implicitly supported by UE when UE reports the supported MG patterns. |
| Apple | Suggest focusing on 2-3-1 |
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#### Sub-topic 2-7 Applicability

**Issue 2-7-1 Measurement requirements applicability**

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| **Company** | **Comments** |
| MTK | Support Option 2-1 which is the same view as Option 1-Case 1.  Do not support Option 1-Case 2.  When there is only NCSG gap,   * In legacy Rel-15, UE can also measure intra-frequency without gap in the MG, but considering the MG utilization, the requirements defined with intra-frequency without gap to be measured outside gap.   In NCSG, we think the same logic can be applied. The NCSG gap should be preserved for the frequency layers which can only be measured in NCSG gap. The frequency layers which can measure both inside and outside NCSG gap shall be measured outside NCSG gap.  Support Option 2-3.  We’re fine to only consider NCSG gap itself in 1st phase and consider the combination of NCSG gap and concurrent gap in 2nd phase, but RAN4 shall consider the forward compatibility when discussing how to consider the type of NCSG. |
| Apple | Technically case 2 in option 1 is feasible, if there is no other limit such as SCS, number of searchers and so on.  Regarding option 2, we can start from single NCSG, wherein option 2-1 makes sense. However, it is quite feasible to support NCSG + legacy MG (like multiple concurrent MG patterns). How to apply CSSF can be firstly discussed in multiple concurrent MG pattern objective. Then we can check if the outcome can be borrowed here. |
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**Issue 2-7-2 RF combination limitation**

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| **Company** | **Comments** |
| MTK | Option 1.  Although UE reports to support NCSG on multiple bands, due to the UE RF implementation, UE cannot always guarantee to conduct measurement simultaneously on 2 inter-frequencies.  Not support option 2.  NCSG means UE can support NCSG because of additional unused RF chains.  There are three kinds of MOs to be measured, which   * needs MG * needs NCSG * doesn’t need both MG and NCSG.   We think all these three MOs can be configured at the same time. Thus, both NCSG and MG can be applied also. We can further discuss the combination of NCSG with concurrent gaps in phase 2. |
| Apple | For option 1 we can address this issue in CSSF design.  Option 2 may need more study. Currently MG is per CC configured. Thus the condition “when measurement gap is configured on all the serving carriers including PCC and SCCs” is not clear to us. Besides, if we consider both NCSG and multiple concurrent MG, then it may become feasible. |
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**Issue 2-7-3 Rx beam limitation**

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| **Company** | **Comments** |
| MTK | Option 1.  For FR2 intra-band or inter-band with CBM, it shall assume UE will use the same Rx beam to receive the signals at one time. UE cannot simultaneously receive data or perform L1 measurements together with L3 measurement by NCSG because UE shall use fine beam to receive the data/L1 measurement but use rough beam to perform L3 measurements. |
| Apple | Observation is valid. As long as beam sweeping is assumed, UE is not expected to do data with serving cell even within ML. |
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**Issue 2-7-4 Searcher limitation**

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| **Company** | **Comments** |
| MTK | Option 1.  In Rel-15, due to hardware limitation, UE is only required to support at least two searchers for NR measurements. However, there is no limitation for inter-RAT measurements. Thus, UE may be able to measure an additional inter-RAT with NR serving cell measurements at a time when UE supports NCSG for this inter-RAT measurements. |
| Apple | We consider replace legacy MG with NCSG. Searcher limitation should still apply. Whether additional inter-RAT measurement can be done in parallel depends on how many carriers are configured to measure. It can be further studied. |
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**Issue 2-7-5 scheduling and measurement restriction**

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| **Company** | **Comments** |
| MTK | Option 1.  Due to this is the 1st meeting, we just want to highlight the issue: RAN4 needs to further study the scheduling and measurement restriction. |
| Apple | Agree this issue is to be studied. |
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#### Sub-topic 2-8 Specification structure

**Issue 2-8-1 Which clause can be used to include NCSG pattern in 38.133**

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| **Company** | **Comments** |
| MTK | Support option 1. |
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#### Sub-topic 2-9 Relation with ‘NeedForGap’

**Issue 2-9-1 How to consider the relation between NCSG and ‘NeedForGap’?**

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| **Company** | **Comments** |
| MTK | Option 1.  In NR Rel-16, a ‘NeedForGap’ mechanism was introduced without RAN4 requirements. The UE can dynamically report whether it supports ‘no gap’ in some band combination by UE capability.  In our understanding, NCSG is exactly the same as ‘NeedForGap’ with interruption allowed.  When NCSG is introduced, we can re-use this NeedForGap reporting for NCSG and further clarify ‘no gap’ means ‘NCSG’ with interruption. In our view, this could bring the following benefits:   * Resolve the ambiguity on whether interruption is allowed when UE indicate ‘no gap’ in NeedForGap’; * Avoid complicated interpretation when both NeedForGap and NCSG capabilities are reported; * More practical to UE implementation since interruption is always allowed. |
| Apple | Prefer option 1. But we would like to collect view on the implication of ‘NeedForGap’ in R16. Does it mean no any interruption is allowed in R16? Or interruption is allowed but length is unclear since no requirements in R16? |
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### CRs/TPs

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| **CR/TP number** | **Comments collection** |
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## Summary for 1st round

### Open issues

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|  | **Status summary** |
| **Issue#2-1-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-1-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-1-3** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round: can be FFS* |
| **Issue#2-2-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-3-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-3-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-3-3** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-3-4** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-4-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-4-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-5-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-5-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-6-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-6-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-7-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-7-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-7-3** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-7-4** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-7-5** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-8-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Issue#2-9-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

## Discussion on 2nd round

Please only comment on topics that are selected for discussion in 2nd round.

## Summary on 2nd round

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| **CR/TP/LS/WF number** | **T-doc status update recommendation** |
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