3GPP TSG-RAN WG4 Meeting #101-e R4-22xxxxx

**Electronic Meeting, 17th – 25th January, 2022**

**Agenda Item: 6.11.2.3**

**Source: Apple**

**Title: WF on NCSG**

**Document for: Approval**

# **Introduction**

This WF is to capture all agreements and open issues for NCSG in RAN4#101e meeting based on email discussion [101-bis-e][211] NR\_MG\_enh\_3.

# **Sub-topic 1: Scenarios and use cases**

**Issue 1-1: NCSG for CSI-RS based inter-frequency measurement with gap**

Candidate options:

* Option 1: NCSG for CSI-RS based inter-frequency measurement with gap is supported in R17. (CATT, vivo, CMCC, Nokia)
* Option 1a: NCSG can be used for CSI-RS inter-frequency measurement. UE reports supported CSI-RS BW for each band. (HW)
* Option 2: NCSG for CSI-RS based inter-frequency measurement with gap is NOT supported in R17. (Apple, QC, OPPO, E///, ZTE, MTK, Intel, Nokia)
* Option 3: RAN4 to work on CSI-RS based inter-frequency measurement requirement via NCSG after stabilizing the SSB-based requirements. (MTK, Intel, ZTE, vivo)
* Option 4: NCSG for CSI-RS based inter-frequency measurement with gap is supported in R17. However, corresponding requirements will not be defined in R17.
* Option 5: NCSG for CSI-RS based inter-frequency measurement with gap is supported in R17. Corresponding requirements will be defined in R17. Introduce a new optional UE capability to indicate support of using NCSG for inter-frequency measurement with gap.

Recommendation from moderator: this issue has been discussed for several meetings. Seems still challenging for proponents of option 1 and 2 to convince each other. Companies are encouraged to focus on possible compromise, such as option 3/4/5. Option 4 and 5 are new proposals from moderator, comments are welcome.

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| **Company** | **Comments in the 2nd round** |
| Apple | Support option 2. Technical point has been widely discussed for several meeting. We can also consider compromised solution 3/4/5. |
| vivo | Ok with option 1 |
| OPPO | Support option 2, but can compromise to option 3. |
| Intel | Option 3. We can target to complete the more fundamental usage firstly. |
| Huawei | We can accept option 1a or option 4 or option 2 (in the order of preference). |
| CATT | We can accept option 1 and option 1a. |
| ZTE | Support Option 2 or 3. |
| MTK | Support option 2, but can compromise to option 3. |
| E/// | We support Option 2. But we can compromise to Option 4. |

**Issue 1-2: NCSG for dormant SCell**

Candidate options:

* Option 1: RRM measurement for dormant Scell is supported in R17. (CATT, Apple, vivo, HW, E///, ZTE, MTK, vivo)
* Option 1a: RRM measurement for dormant Scell is supported in R17. Whether to limit it within NCSG is FFS. (MTK, Apple, vivo)
* Option 2: RRM measurement for dormant Scell is NOT supported in R17. (QC, Nokia, MTK, Intel, OPPO, Nokia)
* Option 3: deprioritize NCSG for dormant Scell. (Intel, Apple, OPPO)

Recommendation from moderator: continue discussion. Companies are encouraged to consider possible compromise (similar to option 4/5 under issue 1-1)

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| **Company** | **Comments in the 2nd round** |
| Apple | In our view RRM measurement for dormant Scell with NCSG can be supported, similar with RRM measurement on deactivated SCC. We also agree that since CQI anyway cannot be measured by NCSG, using NCSG for RRM measurement may become less attractive.  Option 3 is a possible compromise. |
| Vivo | Prefer option 1 and 1a |
| Intel | We can compromised to Option 1 but with the best effort way to support. |
| Huawei | Option 1 or 1a. |
| ZTE | Support Option 1 and 1a. |
| MTK | Suggest to go with Option 1 which seems the majority. So that we close this issue and move on. |
| E/// | Option 1. We don’t see any extra work needed for RRM measurement for dormant SCell. |

**Issue 1-3: whether NCSG under EN-DC, NE-DC and NR-DC is supported in R17**

Agreement in the 1st round:

* RAN4 will not further discuss feasibility of NCSG in EN-DC, NE-DC and NR-DC. The feasibility is expected to be decided in RAN2.

**Issue 1-4: NCSG in FR2**

Agreements in the GTW:

* NCSG can be applied without scheduling restrictions under the following conditions
  + The serving cell(s) and the target cell are on different bands.
  + UE is capable of IBM on the serving cell band and the target cell band.
  + UE is capable of simultaneous Tx/Rx on the serving cell band and the target cell band
* For other cases NCSG can be applied with scheduling restrictions

# **Sub-topic 2: NCSG patterns**

**Issue 2-1: On top of #0 and #1, whether additional NCSG gap patterns shall be mandatorily supported if UE supports NCSG.**

Status in the 1st round:

* Option 1:NCSG patterns corresponding to legacy gap#2, 3, 11, 13, 14, 17, 18, 19 are mandatorily supported (CATT, CMCC)
* Option 1a: The set of mandatory NCSG patterns is same as that for legacy MGPs. (HW, E///, CMCC, ZTE, CATT)
* Option 2: NCSG GP#13 and #14 are mandatorily supported for UE supporting per-FR NCSG. For NR-only measurement, NCSG GP#2, #3, #11, #17, #18, #19 are mandatory. (MTK, CMCC, HW, CATT)
* Option 3: NCSG patterns corresponding to legacy patterns #13 and #14 are mandatorily supported in FR2 for per-FR capable UE. (OPPO, QC, Apple, MTK, Intel)
* Option 4: at least NCSG patterns corresponding to legacy gap#2, 3, 11 are mandatorily supported in FR1 (CMCC)
* Option 5: no additional mandatory NCSG patterns (Apple, QC, vivo, Intel, OPPO, Nokia)

Recommendation from moderator: according to comments in the 1st round, option 3 seems to be a promising middle ground. It is recommended to agree on option 3 first and then continue discussing whether additional mandatory gap patterns are needed. Besides, moderator also tries to merge some options.

Tentative agreement in 2nd round:

NCSG patterns corresponding to legacy patterns #13 and #14 are mandatorily supported in FR2 for per-FR capable UE.

Continue discussion on the following options:

* Option 1:For NR-only measurement, NCSG GP#11, #17, #18, #19 are mandatory.
* Option 2: no additional mandatory NCSG patterns

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| **Company** | **Comments in the 2nd round** |
| Apple | Support tentative agreement. Open to further discussion on new option 1 and 2. |
| Vivo | Ok with the tentative agreement |
| OPPO | The tentative agreement is acceptable for us. And we prefer to not consider additional mandatory NCSG patterns. |
| Intel | OK with the tentative agreement |
| Huawei | Support tentative agreement.  Support option 1 with additional GP#2 and 3. It is not very clear why GP#2 and 3 are excluded.  We also would to reply to **@QC** question in first round: we assume with NCSG the interruption can only happen in the VIL, so UE cannot ON/OFF the spare RF/BB resource based on SMTC. |
| CATT | Fine with the tentative agreement. For FFS part, same view as Huawei, GP#2 and GP#3 should be included. |
| ZTE | Fine with the tentative agreement. And we can not see any reasonable excuse to exclude other mandatory legacy gap patterns. |
| CMCC | OK with tentative agreements. For FFS part, for NR-only measurement, NCSG GP#2, #3, #11, #17, #18, #19 are mandatory, same as agreed in Rel-16 for normal MG. |
| MTK | Support the tentative agreement. |
| E/// | While we support tentative agreement as minimum set of mandatory gaps. But we also support Option 1 since they are mandatory gap patterns from R16. Also we are fine to support GP #2 and 3 as pointed out by HW. |

**Issue 2-2: The existing gap applicability in Rel-16 for NR-only measurement are reused for NCSG**

Status in the 1st round:

* Option 1: yes (CATT, Apple, vivo, Intel, Nokia, CMCC, MTK, vivo, CATT, E///, OPPO)
* Option 2: wait for conclusion from issue 2-1 (QC, ZTE)

Recommendation from moderator: moderator understands that issue 2-2 can be decoupled from issue 2-1. In R16 *supportedGapPattern-NRonly* is used to indicate patterns for NR-only measurement (including other optional patterns). In NCSG, similar design is expected, i.e. UE can indicate support of some NCSG patterns which can only be used for NR-only measurement. Please companies check the following tentative agreement:

Tentative agreement in 2nd round:

UE can indicate support of some NCSG patterns which can only be used for NR-only measurement.

Continue discussion on how to indicate support NR-only NCSG pattern:

* Option 1: reuse *supportedGapPattern-Nronly* (require mapping between legacy gap patterns and NCSG patterns)
* Option 2: introduce a new signaling, e.g. *supportedNCSGPattern-Nronly*
* Option 3:up to RAN2

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| **Company** | **Comments in the 2nd round** |
| Apple | Support tentative agreement. Add a new option 3 on how to indicate support of NR-only NCSG pattern. To decouple this issue with mapping between NCSG and legacy, option 3 is preferred. |
| OPPO | We are fine to indicate the supported NCSG patterns for NR-only measurement. Between the two options of indicating support NCSG, we prefer option 2, which is more flexible. |
| Huawei | Support the tentative agreement, and option 1. |
| CATT | Fine with the tentative agreement. For the signaling, we are fine with option 3, and we think option 1 should be decoupled with the discussion of mapping issue. |
| ZTE | Support tentative agreement and Option 1. |
| CMCC | OK with the tentative agreements |
| MTK | Ok with Option 3. |
| E/// | We support Option 3.  We should inform RAN2 to develop signaling to enable the UE so it can indicate support of some NCSG patterns which can only be used for NR-only measurement. |

**Issue 2-3: time offset for NCSG:**

Candidate options:

* Option 1:The offset of NCSG refers to the starting point of VIL1. (MTK, QC, Apple, Intel, HW, CATT, E///, ZTE)
* Option 2: The offset of NCSG refers to the starting point of ML – RRT. Allow 2 slots interruption for 15kHz, sync, mgta=0. (OPPO, ZTE, HW, CATT, OPPO)

Recommendation from moderator: according to 1st round discussion, most proponents of option 2 can also accept option 1. Only one company has concern on option 1. Could we try to agree on option 1?

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| **Company** | **Comments in the 2nd round** |
| Apple | Support moderator suggestion to agree on option 1. |
| OPPO | Still prefer option 2. As we mentioned in the 1st round discussion, the effective ML location/length can be aligned for NCSG and the corresponding legacy MG. It will be beneficial if the transform between NCSG and legacy MG is supported.  If companies have strong view to support option 1, we can compromise to it and the values of VIL should be informed to RAN2. The VIL is defined in the unit of slots, and is different for sync and async scenarios. |
| Intel | Support moderator suggestion to agree on option 1. |
| Huawei | We prefer option 2 than option 1 after reading OPPO’s comment. In particular, option 1 may be more complex since VIL is defined in the unit of slots. |
| CATT | Fine with option 2. Or we can use the starting point of ML. |
| zte | Prefer Option 2 since it can align the ML location between legacy MG and NCSG as OPPO analyzed. |
| MTK | Support moderator suggestion to agree on option 1. |
| E/// | We agree with OPPO and HW that Option 1 may be an issue as VIL1 is defined in slots.  So we prefer Option 2. |

**Issue 2-4: mgta for NCSG:**

Agreement in the 1st round:

* Introduce a new mgta 0.75ms for NCSG in FR2 only

# **Sub-topic 3: UE capability and NW configuration**

**Issue 3-1-1: meaning of “measurement within gap”**

Candidate options:

* Option 1: basic time interval for measurement period is defined as MGRP.
* Option 2: CSSF is derived within gap

Recommendation from moderator: most companies are very clear about the intention of this issue. Proponent of this issue gave clarification in the 1st round:

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| OPPO | Option 1 is to distinguish which formula of measurement period will be used. For NR intra-frequency measurement, there are two types of measurement period defined in the existing spec.   * Type-1: intra-f measurement without gap defined in clause 9.2.5, where SMTC and/or DRX cycle are considered for measurement period * Type-2: intra-f measurement with gap defined in clause 9.2.6, where SMTC and MGRP and/or DRX cycle are considered for measurement period   Option 2 is to further distinguish which type of CSSF is used for type-1, CSSF for outside gap or CSSF within gap. And it depends on the overlapping between SMTC and MG as shown below.  CSSFoutside\_gap,i in clause 9.1.5.1 for measurement conducted outside measurement gaps, i.e. when intra-frequency SMTC is fully non overlapping or partially overlapping with measurement gaps,  CSSFwithin\_gap,i in clause 9.1.5.2 for measurement conducted within measurement gaps, i.e. when intra-frequency SMTC is fully overlapping with measurement gaps. Even for intra-frequency MO could be measured without gap, the CSSF is CSSF within gap.  We propose this issue because we think a common understanding on the meaning of “measurement within gap” should be reached before discussing UE behaviour. We are fine with both options. |

Please companies check the clarification and further discuss it in the 2nd round:

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| **Company** | **Comments in the 2nd round** |
| Apple | Thanks OPPO for clarification. However, the issue is still not crystal clear to us. Seems most companies have similar understanding on what is “measurement within gap” Suggest to work on CR directly. |
| OPPO | This issue should be solved before discussing UE behaviour like issue 3-1-2.  If the “measurement within gap” means the basic time interval (which is expressed as with gap or without gap in the current spec), then option 2 in issued 3-1-2 is supported;  If the “measurement within gap” means to derive CSSF within CSSF (which is expressed as within gap or outside gap in the current spec), then option 4 in issued 3-1-2 is supported to consider the overlapping situation between SMTC and NCSG. |
| Huawei | We understand the issue can be well addressed by option 4 in 3-1-3. As long as requirements are clear, we may not need to spend too much efforts in formulating the issue. |
| CATT | After further check, we think option 1 means “with gap” and option 2 means “within gap”. But we are fine to work on the requirements directly. |
| ZTE | Thanks OPPO for such concrete clarification, we believe it is needed to align companies’ interpretation of “measurement within gap”. Considering the case when all of the SMTC occasions of a MO without gap are overlapped by the gap, still CSSFwithin\_gap,I is used, so Option 1 is preferred. |
| MTK | This seems a Rel-15 discussion. Given the term “measurement within gap”, it is clearly referring to CSSF, which is Option 2. |
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**Issue 3-1-2: when UE indicates ‘ncsg’ and NW configures MG**

Agreement in the 1st round:

* When UE indicates ‘ncsg’ and NW configures MG, UE shall perform measurement within MG.

**Issue 3-1-2: when UE indicates ‘no-gap-no-ncsg’ and NW configures NCSG**

Candidate options:

* Option 1: Measurement within NCSG with only NCSG interruption allowed (CATT, QC, MTK, Intel)
* Option 2: Measurement outside NCSG (Apple, ZTE, OPPO, HW, Nokia, E///, CMCC, OPPO)
* Option 3: introduce a new flag (similar to *interFrequencyConfig-NoGap-r16*) to let NW decide whether to measure with or without NCSG. (Apple)
* Option 4: (CMCC, ZTE, HW, CATT, E///)
  + If RS occasion (e.g. SMTC) is fully overlapped with NCSG, measurement is performed within NCSG
  + If RS occasion (e.g. SMTC) is not fully overlapped with NCSG, measurement is performed outside NCSG

Recommendation from moderator: continue discussion. May be updated after GTW.

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| **Company** | **Comments in the 2nd round** |
| Apple | Between option 1 and 2, from mobility performance point of view, it is hard to say whether one is better. Measurement opportunity has to be shared among layers which are measured either outside NCSG or within NCSG. Nevertheless, UE behavior has to be defined. Based on majority view, we support option 2. Option 4 is also supported, since for fully overlapped case, measurement has to be done with NCSG. |
| OPPO | Depends on the issue 3-1-1. |
| Intel | Option 1. Can be compromised to Option 2 |
| Huawei | Option 4 |
| CATT | Option 4 |
| ZTE | Option 4 |
| CMCC | Option 4 |
| MTK | We can compromise to Option 4. |
| E/// | Support Option 2 but Option 4 is also OK. |

**Issue 3-1-3: when UE indicates ‘no-gap-no-ncsg’ and NW configures MG**

Candidate options:

* Option 1: Measurement within MG (CATT, QC, MTK, Intel)
* Option 2: Measurement outside MG (Apple, ZTE, OPPO, HW, Nokia, E///, CMCC)
* Option 3: introduce a new flag (similar to *interFrequencyConfig-NoGap-r16*) to let NW decide whether to measure with or without MG. (Apple)
* Option 4: (CMCC)
  + If RS occasion (e.g. SMTC) is fully overlapped with MG, measurement is performed within MG
  + If RS occasion (e.g. SMTC) is not fully overlapped with MG, measurement is performed outside MG

Recommendation from moderator: continue discussion. May be updated after GTW.

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| **Company** | **Comments in the 2nd round** |
| Apple | Similar with issue 3-1-2. Support option 2 and 4. |
| OPPO | Depends on the issue 3-1-1. |
| Intel | Option 1. Can be compromised to Option 2 |
| Huawei | Option 4 |
| CATT | Option 4 |
| ZTE | Option 4 |
| CMCC | Option 4 |
| MTK | Option 4 |
| E/// | Support Option 2 but Option 4 is also OK. |

**Issue 3-1-4: other assumptions when discussing NW configuration and corresponding UE behaviour**

Agreement in the 1st round:

* Only those measurement types RAN4 agreed to be measured via NCSG will be considered
* When NCSG is configured, for a frequency layer that can be measured without MG
  + when SMTC is partially overlapped with NCSG, Kp = 1/(1- (SMTC period /VIRP)) applies
  + when SMTC is fully overlapped with NCSG, the frequency layer should be measured within NCSG and be accounted in the CSSF with NCSG.

Continue discussing the following proposal:

* When UE reports the NCSG capability (‘no-gap-no-ncsg’, ’ncsg’ and ‘gap’) on a target band to network, the reported capability applies to all measurement types agreed by RAN4 on that target band.

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| **Company** | **Comments in the 2nd round** |
| Apple | According to clarification from proponent of the proposal, the intention is to preclude intra/inter-frequency measurement without gap in the discussion. Seems it is overlapped with issue 3-1-2 and 3-1-3. We suggest to skip this issue can directly discuss the previous issues. |
| Huawei | We see some issues in the proposal as commented in first round. |
| CATT | If all the measurement types RAN4 agreed means the measurement can use NCSG, we are fine the proposal. |
| MTK | If companies still see some issue, we are fine to make it FFS. |

**Issue 3-2: Whether additional UE capability is needed for per-UE and per-FR differentiation for NCSG on top of that defined for legacy gap**

Candidate options:

* Option 1: No (CATT, Apple, MTK, OPPO, Nokia, E///, Intel, HW)
* Option 2: Define a per BC indication for per FR NCSG. (HW, QC)
* Option 3: do not rely on R15 capability *independentGapConfig*. Define a new NCSG per-UE and per-FR capability, e.g. *independentNCSGConfig* (QC)

Recommendation from moderator: QC asked for clarification on option 1 in the 1st round. At the meantime, a new option 3 was proposed. Continue discussion.

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| **Company** | **Comments in the 2nd round** |
| Apple | In our view, option 1 means no additional UE capability is needed on top of that defined for legacy gap. We continue supporting option 1. Considering this issue has been discussed for many meeting without conclusion, we can acceptable option 3 if this can help concluding the issue. |
| Huawei | Question on option 3: would this new capability be per UE or per BC? |
| CATT | Option 1. |
| ZTE | Prefer Option 1. |
| MTK | Option 1  There is already a parallel discussion for per BC indication for per-FR gap. We do not see a need to duplicate the same discussion here. Whatever reported there should be assumed directly for NCSG. |
| E/// | We support Option 1.  Question on Option 3. If we introduce new NCSG per-UE and per-FR capability (we assume it is per BC), does it mean that all relevant requirements will be applicable for /defined for both legacy per UE and per FR capabilities and new capabilities (Option 3)? |

# **Sub-topic 4: measurement related requirements**

**Issue 4-0: new signaling deriveSSB-IndexFromCell-inter**

Tentative agreement:

RAN4 agreed to introduce a new network signaling [*deriveSSB-IndexFromCell-inter*] informing UE that the SSB indexes of target cell(s) on a frequency different than serving cell frequency can be derived from a serving cell, and which serving cell to utilize for target SSB indexes derivation.

Recommendation from moderator: exact wording can be discussed in the LS. Continue discussing in this WF on the necessary information for RAN2:

Applicability

* *deriveSSB-IndexFromCell-inter*can only be configured if the SCS of SSB is the same between target cell and the serving cell which is used for SSB indexes derivation.
* *deriveSSB-IndexFromCell-inter* is applicable in both FR1 and FR2.
* UE needs to know which serving cell to be referred under CA.
* The indication is to be [per-MO].

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| **Company** | **Comments in the 2nd round** |
| Apple | Support the tentative agreement and the two bullets under applicability. |
| Huawei | Fine with the tentative agreement and the two bullets under applicability. |
| ZTE | Fine with the tentative agreement and the two bullets under applicability. |
| CMCC | In general, we are fine with the tentative agreement. But the wording of last sentence is not clear, I update it as following based on my understanding.  RAN4 agreed to introduce a new network signaling [*deriveSSB-IndexFromCell-inter*] informing UE that the SSB indexes of target cell(s) on a frequency different than serving cell frequency can be derived from a serving cell, and which means serving cell timing is utilized for target SSB indexes derivation |
| MTK | In our view, we need to provide some more information to RAN2. Such as:   1. UE needs to know which serving cell to be referred under CA. 2. The indication is to be per-target band or per-MO. |
| Apple | To CMCC, the intention of the last sentence is as additional information 1 from MTK. With this clarification, is it OK to keep the original wording and add the additional information in the applicability?  To MTK, we agree the additional information are also important to RAN2. Per-band or per-MO are also fine for us. Slightly prefer per-MO since in theory it can bring more use cases. For instance, if NW can only guarantee well synchronous among some of the layers in the same band, the IE can be per layer configured. |

**Issue 4-1: scheduling restriction in FR1**

Issue 4-1-1: for intra-frequency measurement

Agreement in the 1st round:

* For intra-frequency measurement, existing scheduling restriction requirements apply

Issue 4-1-2: for intra-band inter-frequency measurement

Status in the 1st round:

* Option 1: existing scheduling restriction requirements apply except that all symbols in SMTC windows are restricted. (vivo, HW, MTK, E///)
* Option 2: If deriveSSB-IndexFromCell-inter is true, only UL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted. (QC)
* Option 3: If UE is informed that inter-frequency carriers are timing aligned with the serving cell (UE can utilize serving cell timing to derive the index of SS block transmitted by neighbour cell with different carrier), only the SSB symbols indicated by SSB-ToMeasure are restricted. Otherwise, all symbols in SMTC windows are restricted. (CMCC)
* Option 4: if SFN and frame boundary across serving cell and inter-frequency neighbor cells is aligned, and the timing of SSBs across serving cell and inter-frequency neighbor cells are aligned, only the SSB symbols indicated by SSB-ToMeasure are restricted. Otherwise, all symbols in SMTC windows are restricted. (ZTE)

Recommendation from moderator: according to GTW discussion, option 2 seems promising. Please companies check if option 2 is agreeable or any modification is needed:

Tentative agreement in 2nd round:

If deriveSSB-IndexFromCell-inter is false, existing scheduling restriction requirements apply except that all symbols in SMTC windows are restricted.

If deriveSSB-IndexFromCell-inter is true, existing scheduling restriction requirements apply.

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| **Company** | **Comments in the 2nd round** |
| Apple | Supported the tentative agreement. |
| Huawei | We are in principle fine with the tentative agreement, but why only the UL are restricted? This is intra-band, and we still have the case of mixed numerology where both UL and DL are restricted. |
| Apple | Agree with HW. Original tentative agreement is copied from option 2. Please check the updated tentative agreement. |
| ZTE | Supported the tentative agreement. |
| CMCC | Ok with the updated tentative agreements |
| MTK | We are fine with the 1st part of the tentative agreement.  The garding the 2nd part, we need to be clear that only the serving cell(s) referred to the deriveSSB-IndexFromCell-inter can apply existing scheduling restriction requirements. For other serving cells, e.g., with a different SCS, should still allow restriction in all symbols in SMTC. |
| Apple | @MTK, it would be appreciated if more justification can be provided. Just trying to understand the scenario:  UE is operating with intra-band CA: f1 with 15kHz and f2 with 30kHz. MO on f3 (15kHz) is configured. NW indicates deriveSSB-IndexFromCell-inter for f3 (linked with f1 serving cell). Does MTK mean all symbols in SMTC is restricted on f2 serving cell?  Since UE can already support 15kHz + 30kHz CA, it is rational to assume UE can support 15kHz measurement + 30kHz PDCCH/PDSCH. Therefore, scheduling restriction (if any) can only result from TDD. Following this logic, the scheduling restriction doesn’t have to be on the whole SMTC since UE know when to measure and when to switch back for UL Tx on f3.  Is this correct understanding? |

Issue 4-1-3: for inter-band measurement

Status in the 1st round:

* Option 1: No scheduling restrictions for UE supporting simultaneous Rx/Tx. Scheduling restrictions (on all symbols in SMTC) apply for UE doesn’t support simultaneous Rx/Tx. (vivo, HW)
* Option 2: No scheduling restrictions for UE supporting simultaneous Rx/Tx. Scheduling restrictions apply for UE doesn’t support simultaneous Rx/Tx. If deriveSSB-IndexFromCell-inter is true, only UL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted. (QC)
* Option 3: No scheduling restrictions for UE supporting simultaneous Rx/Tx. Scheduling restrictions apply for UE doesn’t support simultaneous Rx/Tx. If UE is informed that inter-frequency carriers are timing aligned with the serving cell (UE can utilize serving cell timing to derive the index of SS block transmitted by eighbor cell with different carrier), only the SSB symbols indicated by SSB-ToMeasure are restricted. Otherwise, all symbols in SMTC windows are restricted. (CMCC)
* Option 4: no scheduling restriction. UE reports ‘ncsg’ or ‘no-gap-no-ncsg’ on a target band, only if UE can support simultaneous TX-Rx and mix-numerology between this target band and UE’s serving cells. (MTK)
* Option 5: SSB symbols to be measured are restricted when scheduling restrictions apply, and whether scheduling restrictions apply depends on UE capability.
* Option 6: existing scheduling restriction requirements apply except that all symbols in SMTC windows are restricted. (E///)

Recommendation from moderator: similar with issue 4-1-2, please companies check if option 2 is agreeable or any modification is needed:

Tentative agreement in 2nd round:

* No scheduling restrictions for UE supporting simultaneous Rx/Tx.
* Scheduling restrictions apply for UE doesn’t support simultaneous Rx/Tx.
  + If deriveSSB-IndexFromCell-inter is true, only UL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted.
  + Otherwise, all symbols in SMTC windows are restricted.

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| **Company** | **Comments in the 2nd round** |
| Apple | Supported the tentative agreement. |
| Huawei | Supported the tentative agreement. |
| ZTE | Supported the tentative agreement. |
| CMCC | Ok with the tentative agreements |
| MTK | The same comment as Issue 4-1-2 on the case when deriveSSB-IndexFromCell-inter is true |
| Apple | @MTK, we fail to understand the concern. When deriveSSB-IndexFromCell-inter is true, UE knows when to measure within the SMTC windows. UE can work normally on the symbols other than the restricted symbols within SMTC for all other serving cells. |

**Issue 4-2: scheduling restriction in FR2**

Issue 4-2-1: for intra-frequency measurement

Status in the 1st round:

* Option 1: existing scheduling restriction requirements apply.
* Option 2: pending issue 1-4.

Recommendation from moderator: according to GTW agreement, NCSG for FR2 intra-band can be supported with restriction. Please companies if option 1 can be agreed.

Tentative agreement:

Existing scheduling restriction requirements apply.

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| **Company** | **Comments in the 2nd round** |
| Apple | Supported the tentative agreement. |
| Huawei | Supported the tentative agreement. |
| ZTE | Supported the tentative agreement. |
| CMCC | Ok with the tentative agreements |
| MTK | The same comment as Issue 4-1-2 on the case when deriveSSB-IndexFromCell-inter is true |
| Apple | @MTK, this is intra-frequency measurement. deriveSSB-IndexFromCell-inter doesn’t apply here. |

Issue 4-2-2: for intra-band inter-frequency measurement

Status in the 1st round:

* Option 1: If deriveSSB-IndexFromCell-inter is true, only UL and DL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted. (QC)
* Option 2: If UE is informed that inter-frequency carriers are timing aligned with the serving cell (UE can utilize serving cell timing to derive the index of SS block transmitted by neighbour cell with different carrier), only the SSB symbols indicated by SSB-ToMeasure are restricted. Otherwise, all symbols in SMTC windows are restricted. (CMCC)
* Option 3: existing scheduling restriction requirements apply except that all symbols in SMTC windows are restricted (unless new NW assistance information is defined). (HW)

Recommendation from moderator: similar with scheduling restriction in FR1, please companies check if option 1 is agreeable or any modification is needed:

Tentative agreement:

If deriveSSB-IndexFromCell-inter is true, only UL and DL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted.

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| **Company** | **Comments in the 2nd round** |
| Apple | Supported the tentative agreement. |
| Huawei | Supported the tentative agreement. |
| ZTE | Supported the tentative agreement. |
| CMCC | Ok with the tentative agreements |
| MTK | The same comment as Issue 4-1-2 on the case when deriveSSB-IndexFromCell-inter is true |
| Apple | Similar response to MTK as under issue 4-1-3. |

**Issue 4-2-3: for inter-band measurement, the serving band and the target band are with CBM**

Status in the 1st round:

* Option 1: If deriveSSB-IndexFromCell-inter is true, only UL and DL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted. (QC)
* Option 2: existing scheduling restriction requirements shall apply (E///)
* Option 3: existing scheduling restriction requirements apply except that all symbols in SMTC windows are restricted (unless new NW assistance information is defined). (HW)

Recommendation from moderator: similar with previous issue, please companies check if option 1 is agreeable or any modification is needed.

Tentative agreement:

If deriveSSB-IndexFromCell-inter is true, only UL and DL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted.

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| **Company** | **Comments in the 2nd round** |
| Apple | Supported the tentative agreement. |
| Huawei | Supported the tentative agreement. |
| ZTE | Supported the tentative agreement. |
| CMCC | Ok with the tentative agreements |
| MTK | The same comment as Issue 4-1-2 on the case when deriveSSB-IndexFromCell-inter is true |
| Apple | Similar response to MTK as under issue 4-1-3. |

**Issue 4-2-4: for inter-band measurement, the serving band and the target band are with IBM**

Status in the 1st round:

* Option 1: (QC)
  + If inter-band simultaneous Tx and Rx is not supported:
    - If *deriveSSB-IndexFromCell-inter* is true, only UL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted.
  + If inter-band simultaneous Tx and Rx is supported:
    - No scheduling restriction.
* Option 2: (CMCC)
  + If inter-band simultaneous Tx and Rx is not supported:
    - If UE is informed that inter-frequency carriers are timing aligned with the serving cell (UE can utilize serving cell timing to derive the index of SS block transmitted by eighbor cell with different carrier), only the SSB symbols indicated by SSB-ToMeasure are restricted. Otherwise, all symbols in SMTC windows are restricted
  + If inter-band simultaneous Tx and Rx is supported:
    - No scheduling restriction.
* Option 3: no scheduling restriction is needed. UE reports ‘ncsg’ or ‘no-gap-no-ncsg’ on a target band, only if UE can support simultaneous TX-Rx, mix-numerology and IBM between this target band and UE’s serving cells. (MTK)
* Option 4: no scheduling restriction is needed, if UE can support simultaneous TX-Rx. (Nokia)
* Option 5: existing scheduling restriction requirements shall apply (E///)
* Option 6: No scheduling restrictions for UE supporting simultaneous Rx/Tx. Scheduling restrictions apply for UE doesn’t support simultaneous Rx/Tx. All symbols in the SMTC window are restricted (unless new NW assistance information is defined) (HW)

Recommendation from moderator: similar with previous issue, please companies check if option 1 is agreeable or any modification is needed.

Tentative agreement:

* If inter-band simultaneous Tx and Rx is not supported:
  + If *deriveSSB-IndexFromCell-inter* is true, only UL on the SSB symbols indicated by SSB-ToMeasure (and one symbol before and after) are restricted. Otherwise, all symbols in SMTC windows are restricted.
* If inter-band simultaneous Tx and Rx is supported:
  + No scheduling restriction.

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| **Company** | **Comments in the 2nd round** |
| Apple | Supported the tentative agreement. |
| Huawei | Supported the tentative agreement. |
| ZTE | Supported the tentative agreement. |
| CMCC | Ok with the tentative agreements |
| MTK | The same comment as Issue 4-1-2 on the case when deriveSSB-IndexFromCell-inter is true |
| Apple | Similar response to MTK as under issue 4-1-3. |

**Issue 4-3: CSSF**

Candidate option:

* Option 1: The value of CSSF within NCSG is the number of all frequency layers that are assumed to be measured by NCSG.

Status in the 1st round:

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| **Company** | **Comments in the 1st round** |
| QC | We support option 1. |
| Apple | Support option 1. |
| ZTE | We believe for the value of CSSF within NCSG, re-using the similar principle in legacy gap is OK. So based on Option 1, the overlapping issue between SMTC and NCSG should also be considered. For details, an additional limitation can be added into Option 1: The value of CSSF within NCSG is the number of all frequency layers that are assumed to be measured by NCSG and their SMTC are totally or partially overlapping with the NCSG. |
| MTK | Support Option 1 |
| Intel | Option 1. |
| Huawei | We have one question for clarification: does option 1 mean the CSSF value is a simple number count, or is it calculated in the same way as CSSF within MG (where SMTC overlapping are considered)? |
| CATT | Support option 1. We think the frequency layers assumed to be measured already means the SMTC is overlapped with NCSG. |
| E/// | Option 1 is OK |

Recommendation from moderator: most companies are fine with option 1. However, some companies asked for clarification. Please proponent of option 1 address the questions from companies

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| **Company** | **Comments in the 2nd round** |
| Apple | Support option 1.  To ZTE: if the yellow highlighted condition “and their SMTC are totally or partially overlapping with the NCSG” is not met, then the layer shall not be considered as “assumed to be measured by NCSG”. Thus it is unnecessary to add the additional wording.  To HW: not sure if I fully get the question. To our understanding, CSSF indeed is a number count, while SMTC overlapping has to be considered (similar with legacy measurement with MG) |
| Huawei | Thanks Apple for the clarification. Assuming “SMTC overlapping has to be considered (similar with legacy measurement with MG)”, we can also support option 1. |
| ZTE | Support Option 1.  Thanks Apple for the clarification, agree with you. |
| MTK | Thanks for the comment. Yes, we need to consider more detail, especially regarding the overlapping between SMTC and NCSG.   * If a frequency layer with NCSG capability reported by UE has the SMTC which is fully non-overlapped by NCSG, this frequency layer should be removed from CSSF within NCSG   If a frequency layer with no-gap-no-ncsg capability reported by UE has the SMTC which is fully overlapped by NCSG, this frequency layer should be added in CSSF within NCSG |

**Issue 4-4: measurement delay**

Candidate option:

* Option 1: The measurement delay requirements for NCSG can be defined by inter-frequency measurement with gap by replacing the MGRP of legacy gap by MGRP of the NCSG. (MTK)

Recommendations for 2nd round: even though most companies are fine with option 1, moderator believe the wording is not precise. Requirements are different between intra-f measurement with gap and inter-f measurement with gap. Therefore, for intra-f measurement requirement, existing intra-frequency measurement requirement shall be used as baseline.

Companies are encouraged to work on CR ([**R4-2200117**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200117.zip)) directly.

**Issue 4-5: measurement on deactivated SCC**

Agreement in the 1st round:

A deactivated SCC is measured in the same way as Rel-15/16 if its SMTC is fully non-overlapped with NCSG, and the Rel-15/16 interruption requirements apply.

**Issue 4-6: impact on L1 measurement**

Candidate option:

* For L1 measurement in an FR1 serving cell, NCSG is not to be considered in P factor provided that VIL of NCSG is not overlapped with any of the RS for L1 measurement.
* For L1 measurement in an FR2 serving cell,
  + if L1 measurement is impacted by L3 measurement of any target carrier measured with NCSG, P is calculated in the same way as in Rel-15 with VIRP replacing legacy MGRP,
  + if L1 measurement is not impacted by L3 measurement of any target carrier measured with NCSG, NCSG is not to be considered in P factor provided that VIL of NCSG is not overlapped with any of the RS for L1 measurement.
  + L1 measurement is impacted by L3 measurement of a target carrier if the target carrier is intra-frequency carrier or inter-frequency carrier in the same band as the serving cell, or if the target carrier is inter-frequency carrier in different band as the serving cell and UE does not support IBM between the target carrier and the serving cell, otherwise there is no impact.

Recommendation from moderator: continue discussion.

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| **Company** | **Comments in the 2nd round** |
| Apple | FR1 part is fine. Regarding FR2 part, some clarification is expected to make proposal clearer. In our view “L1 measurement is impacted by L3 measurement” means L1 and L3 cannot be done simultaneously. The reasons could be 1) L1-RS is overlapped with VIL; 2) Rx beam for L1 is not available. Reason 1) is easy to be captured in RAN4 spec. Regarding reason 2), we suggest to mimic scheduling restriction (except simultaneous Rx/Tx part) to specify when “L1 measurement is impacted by L3 measurement”. |
| Huawei | We agree with Apple’s comment. |
| MTK | Maybe we still need a bit more discussion. The term “L1 measurement is (not) impacted by L3 measurement” is not 100% clear to us. If SSB periodicity 20ms and SMTC periodicity 40ms are assumed (both 0ms offset), we know that in this case L1 measurement can only be done outside SMTC. Should we say L1 is impacted by L3? |

# **Sub-topic 5: others**

**Issue 5-1: transformation between NCSG and legacy gap**

Candidate option:

* Option 1: No need to define transformation between NCSG and legacy gap. (CATT, Apple, MTK, Intel, ZTE, Nokia)
* Option 2: The transformation between NCSG and legacy MG is done by NW via RRC reconfiguration. (HW)
* Option 3: Support 1-bit signaling mechanism for enabling network to transform: (E///)
  + currently configured legacy measurement gap pattern to corresponding NCSG pattern and
  + currently configured NCSG pattern to corresponding legacy measurement gap pattern
* Option 4: No need to define new transformation between NCSG and legacy gap, given the transformation between NCSG and legacy MG can already be done by NW via RRC reconfiguration

Recommendation from moderator: option 4 is a combination of option 1 and 2 as proposed and supported by some companies. Please companies check if option 4 can be agreed.

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| **Company** | **Comments in the 2nd round** |
| Apple | Support option 4. |
| I*ntel* | Option 1. For Option 4, “the transformation between NCSG and legacy MG can already be done by NW via RRC reconfiguration”, we don’t think there is not any RRC reconfiguration for this purpose until RAN4 inform such transformation is needed. This is “egg and chicken” problem. |
| Huawei | Option 4.  To Intel, we assume this can be done by e.g. de-configuring NCSG and configuring legacy MG in same or different RRC messages, and nothing difference from legacy RRC reconfiguration procedure. |
| CATT | I guess option 4 means the NCSG can be de-configured and reconfigured as legacy gap, if this is the case, we can accept option 4. |
| ZTE | Support option 4. |
| MTK | Option 4.  Same view as Huawei. |
| E/// | We can compromise to Option 4.  We agree that NCSG and legacy MG can be done by NW via RRC reconfiguration. But NW needs to know the relation between NCSG and legacy patterns. So we need mapping or relation between NCSG and legacy patterns. See our comments on issue 5-3. |

**Issue 5-2: Processing/transition time (ΔT) for UE to transform between legacy measurement gap pattern and NCSG pattern, if supported according to issue 5-1**

Recommendation from moderator: according to the 1st round comment, this is a RRC procedure, and all companies agree RRC processing delay can be reused. Moderator understands that no need to explicitly capture any agreement.

**Issue 5-3: Whether to introduce a mapping table between legacy measurement gap patterns and corresponding NCSG patterns**

Candidate option:

* Option 1: No (CATT, Nokia, Intel, Apple)
* Option 2: Yes (MTK, HW, E///, QC, ZTE)

Recommendation from moderator: continue discussion.

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| **Company** | **Comments in the 2nd round** |
| Apple | Support option 1.  A mapping table is helpful in discussion phase for delegates to better understanding which patterns people were discussing about, since at that time there is no explicit NCSG patterns.  For now, a new table dedicated for NCSG pattern is to be introduced in CR R4-2202012 (besides, RAN4 has informed RAN2 (R4-2120306) that a dedicated table will be introduced for NCSG pattern.), we don’t see the need to explicitly define a mapping table in RAN4 spec. |
| Huawei | We support option 2, but we can compromise to option 1. To us this is more specification issue. |
| CATT | Option 1. |
| ZTE | Support Option 2.  Or maybe we can decide this issue until the outcomes for Issue 2-1 and 2-3 are determined, since if applying unified mandatory rule and unified ML location between legacy MG and NCSG, why to specify independent patterns? |
| MTK | As long as all companies are clear about the VIRP, ML of a particular NCSG pattern, we are fine to either option. |
| E/// | Support Option 2.  We had clear agreement that NCSG patterns will be defined corresponding to legacy gap patterns in RAN4#100-e. For same reason mandatory NCSG patterns correspond to legacy mandatory gap patterns.  ***Issue 2-4: ML***  *Agreement:*   * + *MLNCSG = MGLlegacy – 2\*RRT*   ***Issue 2-8: feasibility of NCSG patterns with short ML***  *Agreement:*   * + *RAN4 confirms the agreements in RAN4#100e: Define NCSG patterns corresponding to legacy patterns #0~#23. RAN4 will not further discuss the feasibility of NCSG patterns with short ML.*   This is important for NW to know which NCSG corresponds to legacy gap patterns to allow the NW to transform to legacy pattern via RRC signaling.  So mapping between NCSG and legacy gap patterns should be reflected in the specs. The mapping does not need to be defined in terms of table. It can be expressed by a sentence. We will provide updated CRs on NCSG patterns. |

**Issue 5-4: UE feature list discussion on NCSG support**

Agreements in the 1st round:

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| Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| X-1 | Network controlled small gap (NCSG) | Support of NCSG (Apple, Intel, MTK, ZTE) |  | yes | no | UE cannot be configured with NCSG | per-UE | No | No |  |  | Optional with capability signalling |

Continue discussing on X-2 and X-3 in the 2nd round:

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| Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| X-2 | Network controlled small gap (NCSG) | Supported NCSG patterns (Apple, MTK) |  | yes | no | Network does not know whether some NCSG patterns can be configured to UE | per-UE | No | No |  |  | Optional with capability signalling  NCSG  patterns #0, #1, [x, y, …] are conditional mandatory if UE support X-1 |
| X-3 | Network controlled small gap (NCSG) | Support of NCSG per band in target MO in a band combination for inter-frequency measurement (ZTE) |  |  |  |  | Per-band |  |  |  |  |  |

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| **Company** | **Comments in the 2nd round** |
| Apple | Support X-2. We shall decouple the support of legacy gap and NCSG. Considering more and more gap patterns are to be introduced in future release, it is a bit risky to automatically extend the support of NCSG patterns.  X-3 shall be captured in RRC spec, rather than in UE feature list. |
| Intel | x-2 |
| Huawei | We prefer to use capability for legacy MGP, but we can compromise to X-2 if the generic principle is to use separate capabilities for NCSG. In addition, the outcome of Issue 2-2 and 3-2 should be considered.  X-3 should not be considered in UE feature list. |
| CATT | After further check, we have one question on the agreed X-1, based on previous agreement, NCSG can also be per-FR. So the column of “type” may need update.  For X-2, and X-3 we think they are not needed. |
| ZTE | X-2 and X-3 are not needed. |
| MTK | We need to add X-1 as a prerequisite of X-2.  We do not think X-3 is needed. |
| E/// | We support X-2 but mandatory NCSG patterns need to be updated.  We do not support X-3 |

**Issue 5-5: LS to RAN2**

Recommendations for 2nd round: discuss the LS directly on the LS thread. If agreement can be made on the following aspects, RAN4 shall inform RAN2:

* + Scenarios and use cases
  + NCSG patterns including number of patterns, ML, VIRP, offset and mgta
  + UE capabilities and NW configuration
  + Others, including:
    - Transformation between NCSG and legacy gap, if agreed
    - mapping mechanism between legacy measurement gap patterns and corresponding NCSG patterns, if agreed
    - new signalling to support Frame Timing Alignment between carriers, if agreed

# **Reference**

[1] R4-2120415, WF on NCSG, Apple

[2] R4-2115344, WF on NCSG, Apple

[2] R4-2108348, WF on R17 NR MG enhancements –NCSG (RAN4#99e), Intel

[3] R4-2105792, WF on R17 NR MG enhancements –NCSG (RAN4#98-bis-e), Intel

[4] R4-2117602, General issues for measurement gap enhancement WI, MediaTek Inc., Intel Corporation, Apple