3GPP TSG RAN WG1 #117 R1-240xxxx

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**Agenda item: 9.10.1**

**Source: Moderator (Nokia)**

**Title: Moderator summary #1 - Enabling TX/RX for XR during RRM measurements**

**Document for: Discussion and Decision**

# Introduction

The following objectives were agreed to be part of Rel19 WI on XR, XR (eXtended Reality) for NR Phase 3 [1]:

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| - Study and if justified, specify aspects related to multi-modality (intra-UE) (with coordination with SA2/SA4 as needed by LS request). Aim to facilitate efficient and effective support for XR application with Multiple QoS flows with multi-modal inter-dependencies, meeting multi-modal QoS requirements, e.g. synchronization and/or coordination. Efficiency enhancements are expected to be visible in terms of capacity or power consumption. [RAN2].  NOTE: Check in RAN#105 (check also other WG involvement if needed).  - Specify enhancements to enable transmission/reception in gaps/restrictions that are caused by RRM measurements (from inter-frequency RRM measurement gaps, or intra-frequency measurements, or other scheduling restrictions etc). [RAN1, RAN2, RAN4]  - Specify the corresponding measurement gap and scheduling restriction to enable the identified enhancements with RRM performance impact taken into consideration, work being triggered by LS. [RAN4]  - Specify Enhancements for Scheduling, as follows:  - For the UL, Study and if justified, Specify enhancements using delay/deadline information, for support of UL scheduling to enable high XR capacity while meeting delay requirements/avoiding too late PDUs. [RAN2].  NOTE: LCP implementation complexity need to be taken into account when evaluating solutions.  NOTE: Check in RAN#105  - Specify the following user plane enhancements [RAN2]  - RLC re-transmission related enhancements for operation of RLC Acknowledged Mode (AM) with small packet delay budget.  - Specify Core requirements related to the above objectives as necessary [RAN4]   * Extend Release 18 standalone mechanism to support NR-NR dual connectivity as follows [RAN3]   + PDU set based handling   + ECN marking   + Burst Arrival Time reporting, if needed   + PSI Discard coordination, if needed   + Note: No RAN2 impact from above items   NOTE: Whether / to what extent network exposure / RAN awareness / e.g. RAN involved rate control, possibly additional info for DL scheduling, parallel with SA2 work, shall be covered in this WI is TBD. |

According to the Work Item description [1], RAN1 shall carry the normative work for the following objective:

* Specify enhancements to enable transmission/reception in gaps/restrictions that are caused by RRM measurements (from inter-frequency RRM measurement gaps, or intra-frequency measurements, or other scheduling restrictions etc). [RAN1, RAN2, RAN4]

This document provides a summary of contributions submitted to RAN1#117 under agenda item 9.10.1 Enabling TX/RX for XR during RRM measurements.

# Enabling TX/RX for XR during RRM measurements

## Solutions based on network signalling

### General

#### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| NTT DOCOMO | Observation 1: A solution with most generic usage would be more meaningful. |
| Ericsson | Observation 1. The design alternatives should be assessed to decide for a baseline design approach that results in a feature providing improved performance with reasonable level of complexity. |
| LG | Proposal 1: Consider to support one or more solutions for both periodic and aperiodic gaps/restrictions |
| MediaTek | Observation 1: Network-controlled solutions are suitable from the perspective of XR traffic arrival characteristics while UE-triggering based solutions are suitable from the perspective of satisfying measurement requirements.  Proposal 1: Enhancements to relax scheduling restrictions shall be used/activated only when the scheduling restriction is imposed on the XR high-priority packet transmission/reception. |
| Nokia | Observation 1: For DL XR traffic with time-domain jitter, it is hard to predict if a future gap/restriction appearing in 40ms or 80ms will cause problems for scheduling the XR payload.    Observation 2: For UL XR traffic without time-domain jitter, it is easy to predict if a future SMTC window appearing in e.g. 40ms or 80ms will cause problems for scheduling the UL XR payload, but still low probability of multiple consecutive SMTC windows colliding with UL XR traffic due to misalignment of SMTC windows and XR frame arrivals. |
| Sony | Proposal 3: Other solution(s) than dynamic indication can be further studied (e.g., on the applicability, and scenarios).  Proposal 4: Temporary measurement gap modification to enable Tx/Rx can be at least in a form of skipping a gap/restriction occasion. |
| TCL | Observation 1: XR services have the following characteristics.   * The non-integer periodicity * Jitter of packet arrival time * Low latency and large packet size * Varying packet size * Multiple flows |

### Dynamic indication (Alt. 1)

#### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| CATT | Proposal 1: The Alt.1: dynamic indication solution should not be supported in Rel-19 XR enhancement, because it requires the expected prediction of XR traffic arrival in the near future and is not realistic in providing the benefit of improving the system capacity for XR. |
| CMCC | Proposal 1. For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements, support the following alternatives:   * Alt. 1-1: Explicit indication by DCI to skip a particular gap/restriction; * Alt. 2-3: Activate/de-activate one or more of pre-configured pattern(s) via MAC-CE to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s). |
| NTT DOCOMO | Observation 2: Dynamic indication based solution is applicable regardless of XR traffic characteristic.  Proposal 1: Dynamic indication based solution is supported to enable Tx/Rx in gaps/restrictions.  Proposal 2: For dynamic indication based solution, support Alt 1-1 with following update.   * Alt 1-1: DCI indicates skipping for the first gap/restriction which is with a required duration after the indication DCI. |
| Ericsson | Observation 2 . Due to uncertainty in application packet arrival and size, as well as uncertainty in scheduling a transmission and/or its retransmission, , a dynamic solution provides the network with the flexibility needed to improve XR capacity when a MG is required to enable UE measurements in a particular occasion or being skipped.  Observation 4 . Among the dynamic solutions under Alt. 1, Alt- 1-1 is the simplest and the most robust and efficient solution. Alt. 1-2 results in unnecessary complexity as compared to Alt. 1-1 without demonstrating additional benefit. Atl. 1-3 is the least robust solution and can potentially results in additional delay in scheduling depending on the required timeline.  Proposal 2 . For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements:  • Solutions based on Alt. 1-1 are supported.  • Solutions based on Alt. 1-2 and Alt. 1-3 are not supported.  Proposal 5. Support dynamic indication of cancellation of a MG occasion by a bit-field in a DCI format carried by PDCCH as the baseline approach.  • A bit(s) in the cancellation field is associated to a MG occasion(s) starting after the last symbol of the PDCCH carrying the DCI format and indicates whether the MG occasion(s) is cancelled.  • When a MG occasion is indicated cancelled, it should be remained cancelled.  • The first cancellation indication should satisfy a timeline with respect to the cancelled MG occasion(s).  • DCI \_1, X\_2 and X\_3 can be configured with the MG cancellation indication field. |
| Google | Proposal 1: For network based solutions, support further shortlisting to the following alternatives:  •Alt. 1-1: Explicit indication by DCI to skip a particular gap(s)/restriction(s);  •Alt. 1-3: Implicit indication by DCI scheduling a transmission/reception overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s);  •Alt. 3-4: Gaps/restrictions that are caused by RRM measurements are skipped based on semi-statically configured priority information for particular semi-statically pre-configured Tx/Rx and/or particular gaps/restrictions.  Proposal 2: The UE can be signalled/configured to monitor PDCCH associated with a specific PDCCH configuration (e.g., scheduling XR traffic) during measurement gaps/restrictions.    Figure 1: Dynamic scheduling of data overlapping with MGs is an implicit indication to skip the MG and transmit/receive the data |
| Huawei | Proposal 2: RAN1 can further consider the following alternatives:  • (Alt 1-2) Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s).   1 or more lengths of time window are configured by RRC.   DCI contains 1 or 2 bits to indicate one length of time window.  • (Alt 3-1) Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions:   Starting position, periodicity and duration of the pattern, and a threshold are RRC configured.   If the overlapping ratio between the duration of pattern and the duration of RRM measurements is larger than the threshold, the RRM measurements are cancelled.    Figure 1. Illustration of cancelling/skipping the measurement gaps within a time window through dynamic signaling    Figure 2. Illustration of cancelling/skipping different types of measurement gaps |
| III | Proposal 1: Implicit indication by DCI scheduling a transmission/reception overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s) (Alt 1-3) has less specification impact. |
| InterDigital | Observation 3: Dynamic-indication based solutions are flexible to handle dynamic characteristics of XR data and enable the NW to control how much of the Tx/Rx of XR data can be allowed during RRM measurements  Proposal 2: RAN1 to prioritize the following dynamic indication-based solutions to enable Tx/Rx in gap(s)/restriction(s)   * Alt 1-1: Explicit indication by DCI to skip a particular gap(s)/restriction(s) * Alt 1-3: Implicit indication by DCI scheduling a transmission/reception overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s) |
| Lenovo | Proposal 1: If the time offset is agreed to be small (e.g., less than 2ms): Adopt Alt 1-3 for dynamic scheduling.  Proposal 2: If the time offset is agreed to be large (e.g., larger than 2ms): Adopt Alt 1-1/1-2 for dynamic scheduling. |
| LG | Proposal 2: Support Alt. 1 for the solution to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements   * For Alt. 1, consider the scheduling-perspective DCI and gap-perspective DCI/MAC-CE approaches as potential solutions.   + The scheduling-perspective DCI can indicate to allow Tx/Rx in gaps/restrictions by scheduling DL/UL resource to be overlapped with the gaps/restrictions.     - FFS whether to introduce a new DCI field for this indication.   + The gap-perspective DCI/MAC-CE can indicate an index of gaps/restrictions configuration (where index for each of configuration can be preconfigured by RRC) and the time duration(s) where Tx/Rx is allowed for the indicated gaps/restrictions configuration.     - Group-common signaling can be considered for this indication.   Proposal 3: For Alt. 1, a new DCI format can be introduced.   * The searchspace for the DCI format is required to be monitored only when there is an upcoming gap/restriction that are caused by RRM measurements. |
| MediaTek | Observation 2: Dynamic indication to enable Tx/Rx is useful when network uses dynamic UL/DL grants to schedule XR packets.  Proposal 8: For dynamic indication, support Alt 1-1. Consider a new bitfield in the DCI dynamic scheduling grant to indicate whether one or more of the following measurement occasions are skipped.  A diagram of a graph  Description automatically generated |
| Meta | Proposal 1: For the network signaling based solutions, down-select Alt.1 to be further studied. |
| NEC | Proposal 1: for solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions, support Alt 1, i.e., dynamic indication.  Proposal 2: For dynamic indication of gaps/restrictions skipping, support both the implicit indication (i.e., Alt 1-3) and explicit indication (Alt 1-1 or Alt-1-2). For the explicit indication, indication of multiple MGs/restrictions should be supported for better flexibility. |
| Nokia | Observation 3: Implicit DCI indication (Alt 1-3) policy increase latency and reduce scheduling flexibility in the presence of the UE timeline constraint.  Proposal 1: We recommend prioritizing Alt 1-1 with explicit DCI-based indication to skip a single upcoming measurement occasion i.e. measurement gap or restriction.  Proposal 2: We recommend to de-prioritize Alt 1-2 with DCI to explicitly indicate a time window where to skip a particular gap(s)/restriction(s) as indication for multiple gap/restrictions is not needed.  Proposal 3: We recommend to de-prioritize Alt 1-3 with implicit DCI indication of measurement gap skipping when scheduling a transmission/reception overlapping with a measurement gap.  Proposal 4: Introduce a method to trigger cancellation of a single upcoming measurement gap/restriction without scheduling a DL/UL grant. The design of the format can be based on format 2\_4, including similar requirements for UE processing times or be an extension/modification of existing DCI format (x\_1, x\_2). |
| OPPO | Proposal 2: Dynamic indication to enable Tx/Rx in gaps/restrictions caused by RRM measurements can be considered, with the following focus:   * Alt 1-3: Implicit indication by legacy DCI scheduling a PDSCH/PUSCH/PUCCH overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s); * Alt 1-1: Explicit 1-bit indication in DCI format X\_1/2/3 to indicate whether to skip the first gap(s)/restriction(s) occasion that is a type eligible for cancellation/skipping per RAN4 assessment and meanwhile satisfies the condition in terms of time offset between the end of DCI reception and the start of gap(s)/restriction(s) occasion.   + If there are multiple DCI’s indicating a same first gap(s)/restriction(s) occasion, UE skips the gap(s)/restriction(s) occasion if any one of the DCI, regardless of order in time, indicates to cancel/skip the occasion. |
| Panasonic | Proposal 2: For the dynamic indication, using a dedicated filed or a new PHY priority index in DCI should be used. |
| Qualcomm | Observation 1. There is no strong motivation to support on demand deactivation of measurement gap occasion(s) using DCIs with XR predictable traffic and small jitter.  Observation 2. With Alt 1-1/Alt 1-2, the timeline requirement between the DCI and the start of the measurement gap introduces delays in scheduling until after the DCI deactivates a gap. With Alt 1-3, the timeline requirement introduces delays in scheduling transmissions in the DL/UL.  Observation 3. The DCI based indication requires extensive specification efforts that may not be finalized within the 0.5 TUs allocated for XR. Some of the discussions that RAN1 will need to discuss include whether the DCI is a scheduling DCI or non-scheduling DCI, GC-DCI, or UE specific DCIs, whether legacy DCIs or new DCI formats, DCI content and bit size, DCI size budget, reliability of the indication.  Proposal 1. DCI based deactivation of gaps/restrictions is not supported for deactivation of gap(s)/restriction(s). |
| Samsung | Proposal 1: Support Alt. 1-1 by adding one bit in UE-specific DCI formats (other than DCI format 0\_0/1\_0) to indicate whether or not a UE skips a next MG (and continues receptions/transmissions if the UE skips the next MG). |
| Sony | Proposal 1: Support dynamic indication (i.e., via DCI) to enable Tx/Rx in particular gap(s)/restriction(s) that are caused by RRM measurements.  Proposal 2: The DCI contains an explicit indication to skip a particular gap(s) /restriction(s) for one or more occasions, known as Alt.1-1. |
| Spreadtrum | Proposal 1: Alt 1-1 can be one candidate solution, considering the following aspects:   1. Scheduling DCI formats can be used 2. A new field in DCI format to indicate the skipping 3. Only applicable to the next MG/restriction after time offset |
| TCL | Proposal 1. For dynamic data transmission, when the time domain resource of the scheduled data by the DCI is overlapped with the measurement gap, then UE need to skip measurement and perform data transmission/reception within a measurement gap (Alt 1-3).  Proposal 2: UE-specific DCI format (e.g. DCI format 0\_x/1\_x) can be used for dynamic indication to enable Tx/Rx within measurement gap(s)/restriction(s). |
| ZTE | Observation 1: The delay for indicating to enable Tx/Rx in gap(s)/restriction(s) via DCI is shorter than the delay through MAC CE signaling.  Proposal 1: Support to specify Alt 1-1, i.e., explicit indication by DCI to skip a particular gap(s)/restriction(s) including,  • The new bit field design in DCI signaling  • FFS: whether new DCI format is considered.  Proposal 2: Support to specify Alt 1-2, i.e., explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s) , including:  • The configuration of the time window  • New bit field design in DCI signaling  • FFS: whether new DCI format is considered.  Proposal 3: Do not support Alt 1-3, i.e., implicit indication by DCI scheduling a transmission/reception overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s).  Proposal 4: DCI signaling indicates gaps/restrictions belonging to one configuration or multiple configurations should be considered. |

### Semi-persistent solution (Alt. 2)

#### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Apple | Proposal 1: To facilitate adaptation of legacy MGs, Network Controlled Small Gaps, MGs for multi-SIM, MGs for positioning with a unified signaling design, MGs can be indexed. A MG index set consists of one or more MG index, MGs referred by a MG index set can be skipped through a single NW indication.  Proposal 1a: A MG index set consists of one or more MG index, MGs referred by a MG index set can be skipped through a single NW indication.  Proposal-2: Support Alt 2-2 within the semi-persistent solutions and Alt. 3-2 within the semi-static solutions. And with a periodic or semi-persistent configuration, a time-window period, a time-window offset, and time-window duration are provided to derive time windows.  Proposal-3: To support multiple data flows, one or more semi-persistent configurations can be activated.  Proposal-5: Proposal 4: support non-integer periodicity for periodic configuration/semi-persistent configuration targeting RRM measurement gap adaptation (skipping).  Proposal 6: Discuss and decide the handling of partial overlap of MG/scheduling restriction with a time-window.    Figure 3 Periodic/semi-persistent configuration for RRM measurement adaptation |
| CATT | Proposal 2: The Alt.2: semi-persistent solution should be down-selected, because it can introduce the additional signaling overhead to carry the activation and de-activation command without obvious advantage compared to the Alt 3: the semi-static solution. |
| CMCC | Proposal 1. For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements, support the following alternatives:   * Alt. 1-1: Explicit indication by DCI to skip a particular gap/restriction; * Alt. 2-3: Activate/de-activate one or more of pre-configured pattern(s) via MAC-CE to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s). |
| NTT DOCOMO | Observation 3: If XR traffic pattern can’t be matched well by pre-configured periodicity and offset, semi-persistent solution and semi-static solution may result in degraded RRM measurement performance without much improvement on XR capacity. |
| Ericsson | Observation 5. Alt. 2-2 and Alt. 2-3 based solutions achieve the same goals as Alt. 2-1 with additional complexity.  Observation 6. Solutions based on Alt. 2-1 can be considered as a dynamic solution, while being more conservative and hence resource inefficient as compared to Alt. 1-1  Observation 7. Alt. 2-1a improves the underlying measurement framework. Therefore, it can be beneficial to apply the dynamic solutions on an improved measurement framework to maximize the improvements in serving XR traffic.  Proposal 3. For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements:  • Solutions based on Alt. 2-1 can be considered for further study if it is proven to be superior to Alt. 1-1 based solutions.  • Solutions based on Alt. 2-2 and Alt. 2-3 are not supported.    Figure 1 Illustration of usability of MGs for RRM purposes based on UEs locations in the cell. |
| Fraunhofer | Proposal 3: To avoid any misunderstanding between gNB and the UE about whether MG occasions are deactivated or not, MG occasions are by default considered as activated until UE receives the MAC CE command or network receives the HARQ-ACK about the PDSCH reception.  Observation 2: The semi-persistent signaling approach may offer more flexibility in the indication of the MG occasions that can be deactivated, but it may also be more sensitive to the XR traffic characteristics. There is no strong motivation to support semi-persistent signaling as a standalone solution.  A screenshot of a computer  Description automatically generated  Figure 3: Timeline of the MG activation/deactivation MAC CE command. |
| III | Proposal 2: To avoid activate/de-activate signals being transmitted frequently, it is more appropriate to activate/de-activate one or more pre-configured pattern(s) instead (Alt 2-3). |
| InterDigital | Proposal 3: RAN1 to prioritize the following semi-persistent solutions to enable Tx/Rx in gaps/restrictions   * Alt 2-1: gNB sends a skipping activation command, UE will skip gaps/restrictions until de-activation command is received. * Alt 2-3: Activate/de-activate one or more of pre-configured pattern(s) via MAC-CE to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s) |
| LG | Proposal 4: Deprioritize Alt. 2 for the solution to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements |
| MediaTek | Proposal 6: For semi-persistent solution, support Alt 2-3. Consider a time-domain pattern configuration to set higher priority for XR transmission/reception on the occasions indicated by the pattern and to allow RRM measurements on other occasions not indicated by the pattern. |
| Nokia | Proposal 5: De-prioritize semi-persistent solutions with deactivation/activation of SMTC windows as those are anticipated to offer no benefits over dynamic DCI based solutions. Thus, de-prioritize Alt 2-1, 2-2, and 2-3. |
| Panasonic | Proposal 3: For the semi-persistent solution, a new PHY priority index should be introduced to CG/SPS configurations. |
| Qualcomm | Proposal 3. MAC-CE can deactivate gaps/restrictions; the activation of gaps with MAC-CE is not supported.  Proposal 4. Semi-persistent deactivation of measurement gap configuration/occasions using MAC-CE based indication can be signalled by the network and indicates deactivation of occasions within a time window.  Proposal 5. Support MAC-CE indication for deactivation of gaps/restrictions, Alt 2-2, and Alt 2-1 with clarification that any further activation is based on RRC reconfiguration.   * + - Alt 2-1: gNB sends a skipping activation command, UE will skip gaps/restrictions until de-activation command is received.       * Subsequent activation of gaps is based on RRC reconfiguration and not based on MAC-CE.     - Alt 2-2: RRM measurement adaptation is applied to all MG configurations/scheduling restrictions due to all SMTC configurations or is applied to selected MG configuration(s) and/or scheduling restrictions due to selected SMTC configuration(s) and is conducted in a time-window, and time-windows are derived from a semi-persistent configuration activation for their periodicity, offset and duration. |
| Samsung | Observation 1: There is no need and is disadvantageous for a gNB to indicate to a UE to skip multiple MGs. |
| Spreadtrum | Proposal 2: Alt 2-3 can be one candidate solution, considering the following aspects:   1. MAC-CE activate one or more of pre-configured pattern(s) to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s) 2. A configured pattern includes usable information of MG/restriction occasions in a time window 3. The time window is periodic with fix length 4. Usable information of MG/restriction occasions in a time window can be indicated by activation MAC-CE     Figure 3. An example of Alt 2-1 and 2-3.    Figure 4. An example of Alt 2-3. |
| Xiaomi | Observation4：The utilization of Alt.2 can enhance the flexibility of semi-static schemes and decrease the transmission frequency of dynamic signaling.  Proposal 5：Advocate for Alt.2 as the baseline solution, and down select between Alt 2-1 and Alt 2-1a. |
| ZTE | Proposal 5: Support Alt 2-1, Alt 2-1a and Alt 2-2 for semi-persistent solutions to enable Tx/Rx in gaps/restrictions. And it depends on RAN2 to design details of MAC CE signaling.  Proposal 6: MAC CE signaling indicates gaps/restrictions belonging to one configuration or multiple configurations should be considered. |

### Semi-static solution (Alt. 3)

#### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Apple | Proposal-2: Support Alt 2-2 within the semi-persistent solutions and Alt. 3-2 within the semi-static solutions. And with a periodic or semi-persistent configuration, a time-window period, a time-window offset, and time-window duration are provided to derive time windows.  Proposal-4: To support multiple data flows, one or more semi-static configurations can be activated.  Proposal-5: Proposal 4: support non-integer periodicity for periodic configuration/semi-persistent configuration targeting RRM measurement gap adaptation (skipping).  Proposal 6: Discuss and decide the handling of partial overlap of MG/scheduling restriction with a time-window. |
| CATT | Proposal 3: The Alt.3-3: semi-static solution should be supported for its less signaling overhead and simple implementation, in which gaps/restrictions that are caused by RRM measurements are skipped if collided with particular semi-statically pre-configured Tx/Rx occasions.  Proposal 4: The rule-based semi-static solution should NOT be supported, in which gaps/restrictions that are caused by RRM measurements are skipped under the certain condition. |
| NTT DOCOMO | Observation 3: If XR traffic pattern can’t be matched well by pre-configured periodicity and offset, semi-persistent solution and semi-static solution may result in degraded RRM measurement performance without much improvement on XR capacity. |
| Ericsson | Observation 3. Any semi-static approach is simple from UE perspective but inefficient from the NW perspective. Due to the inbuilt uncertainty on the need for utilizing a MG for serving the traffic, determining a proper configuration/pattern/time window that meets the intended objectives is impractical and results in resource wastage and unnecessary complexity.  Proposal 1. For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements:  • Solutions based on Alt. 3 (i.e. Alt. 3-1/2/3/4) are not supported. |
| Fraunhofer | Observation 1: Semi-static indication of MG occasions using RRC signaling is well adapted to the predicable XR traffic and to its characteristics.  Proposal 1: As baseline solution, support Alt. 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip MGs/restrictions. |
| Google | Proposal 1: For network based solutions, support further shortlisting to the following alternatives:  •Alt. 1-1: Explicit indication by DCI to skip a particular gap(s)/restriction(s);  •Alt. 1-3: Implicit indication by DCI scheduling a transmission/reception overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s);  •Alt. 3-4: Gaps/restrictions that are caused by RRM measurements are skipped based on semi-statically configured priority information for particular semi-statically pre-configured Tx/Rx and/or particular gaps/restrictions.  Proposal 4: Skip a measurement gap if the priority of the overlapping transmission is above a configured priority threshold. |
| Huawei | Proposal 2: RAN1 can further consider the following alternatives:  • (Alt 1-2) Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s).   1 or more lengths of time window are configured by RRC.   DCI contains 1 or 2 bits to indicate one length of time window.  • (Alt 3-1) Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions:   Starting position, periodicity and duration of the pattern, and a threshold are RRC configured.   If the overlapping ratio between the duration of pattern and the duration of RRM measurements is larger than the threshold, the RRM measurements are cancelled. |
| III | Observation 1: The MGs and the pre-configured Tx/Rx conflict are occurs on the UE side, so the UE needs to choose whether to skip the MG.  Proposal 3: Gaps/restrictions that are caused by RRM measurements are skipped based on semi-statically configured priority information for particular semi-statically pre-configured Tx/Rx and/or particular gaps/restrictions (Alt 3-4) need to be supported. |
| InterDigital | Observation 1: Scheduling restrictions can have major impact on transmission/reception of XR data with tight delay budgets. Delaying the transmissions to after MG results in not meeting QoS and impacts capacity.  Observation 2: Semi-static approaches for reconfiguring gaps/restrictions to not overlap with the data TOs can cause additional delays when addressing issues related to jitter during XR data arrival  Proposal 4: RAN1 to prioritize the following semi-static solution to enable Tx/Rx in gaps/restrictions   * Alt 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions |
| Lenovo | Proposal 3: Adopt Alt 3-3/3-4 for semi-static/semi-persistent scheduling. |
| LG | Proposal 5: Support Alt. 3-3 or 3-4 for the solution to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements   * Deprioritize Alt. 3-1 / 3-2 like approaches, which requires to configure pattern/time window to enable TX/RX * Introduce a new RRC parameter to indicate where the cancellation/skipping is applied. |
| MediaTek | Proposal 7: For semi-static solution, support Alt 3-1. Consider a time-domain pattern configuration to set higher priority for XR transmission/reception on the occasions indicated by the pattern and to allow RRM measurements on other occasions not indicated by the pattern.  A diagram of a graph  Description automatically generated  Figure 3 Time-domain mask configuration can relax scheduling restrictions on time instances where XR traffic is expected to be transmitted/received. |
| Nokia | Proposal 6: Alt 3-1/3-3 can be considered as complements to Alt 1-1. But, as Alt 1-1 offers better flexibility it should be standardized first.  Proposal 7: We recommend to de-prioritize Alt 3-2 with semi-static indication of measurement gap skipping when scheduling a transmission/reception overlapping with a measurement gap.  Proposal 8: Alt. 3-4 is seen as an optimization where further justification in terms of performance benefits is needed if decided to standardize semi-static RRC solutions. |
| OPPO | Proposal 1: Alt 3-3 in RAN1 #116bis agreement is supported, in order to handle XR traffic delivered by CG-PUSCH/SPS-PDSCH.   * The “particular semi-statically pre-configured Tx/Rx occasions” in Alt 3-3 refers to the valid CG/SPS transmission occasions corresponding to a CG/SPS configuration that is configured to allow MG cancellation in case of overlaps in time with an occasion of measurement gaps/restrictions.     Figure1. Semi-static solution to enable TX/RX in gaps/restrictions caused by RRM measurements |
| Qualcomm | Proposal 2. Support Alt 3-1 and/or Alt 3-4 for semi-static deactivation of measurement gap.   * + - Alt 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions.     - Alt 3-4: Gaps/restrictions that are caused by RRM measurements are skipped based on semi-statically configured priority information for particular semi-statically pre-configured Tx/Rx and/or particular gaps/restrictions.   A screenshot of a video game  Description automatically generated  Figure 3: Enhanced Measurement Gaps with Alt 3-1.    Figure 4: Collision resolved with semi-static priority that resolves the collision between CG- MG, SPS-MG, SR-MG. |
| Samsung | Observation 2: There is no need and is disadvantageous for a gNB to semi-statically indicate skipped MGs to a UE. |
| Spreadtrum | Proposal 3: Alt 3-1 can be one candidate solution, considering the following aspects:   1. Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions; 2. A configured pattern includes usable information of MG/restriction occasions |
| TCL | Proposal 5: Priority rule for enabling Tx/Rx for XR during RRM measurement can be considered. |
| vivo | Proposal 3: For solutions based on triggering/enabling by network signalling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements, prioritize the following alternatives with UE assistance information report.   * Alt. 3: Semi-static solution to enable TX/RX in gaps/restrictions that are caused by RRM measurements.   + Alt 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions;   + Alt 3-3: Gaps/restrictions that are caused by RRM measurements are skipped if collided with particular semi-statically pre-configured Tx/Rx occasions.   + Alt. 3-4: Gaps/restrictions that are caused by RRM measurements are skipped based on semi-statically configured priority information for particular semi-statically pre-configured Tx/Rx and/or particular gaps/restrictions. |
| ZTE | Proposal 7: Do not support the Alt 3, i.e., Semi-static solution to enable Tx/Rx in gap(s)/restriction(s). |

### Combination of alternatives

#### Companies proposals and observations

|  |  |
| --- | --- |
| **Company** | **Proposals/Observations** |
| Ericsson | Proposal 4. Consider investigating the following approach as combination of Alt.1-1 and Alt. 2-1a design solutions:  • Configured MGs can be enabled or canceled by activation commands (i.e. Alt- 2-1a).  • (Baseline): Configured MGs are activated. Dynamic indication can skip a MG occasion(s) for data TX/RX when needed.  • (Complementary): Configured MGs are deactivated. Dynamic indication can activate a MG occasion(s) for RRM when needed. |
| Fraunhofer | Observation 2: The semi-persistent signaling approach may offer more flexibility in the indication of the MG occasions that can be deactivated, but it may also be more sensitive to the XR traffic characteristics. There is no strong motivation to support semi-persistent signaling as a standalone solution.  Proposal 4: In combination with the baseline RRC-based solution, support Alt. 2-3: Activate/de-activate one or more of pre-configured pattern(s) via MAC CE to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s).  Observation 4: Similar to the semi-persistent approach, there is no strong motivation to support dynamic signaling as a standalone solution.  Proposal 6: In combination with the baseline RRC-based solution, support Alt. 1.2: Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s).  Proposal 7: Further discuss the relationship between the MG activation/deactivation command and the different types of MG configured to the UE:   * Option 1: The same bitmap is used for all the different MG configurations, * Option 2: One bitmap is used for each MG configuration. |
| Lenovo | Proposal 3: Adopt Alt 3-3/3-4 for semi-static/semi-persistent scheduling. |
| MediaTek | Proposal 5: Support both semi-persistent solution (Alt-2) and dynamic indication (Alt-1) for network-controlled mechanism. |
| Nokia | Proposal 6: Alt 3-1/3-3 can be considered as complements to Alt 1-1. But, as Alt 1-1 offers better flexibility it should be standardized first. |
| Panasonic | Proposal 1: A combination of dynamic and semi-persistent solutions should be supported for MG skipping. |

### Moderator's summary of contributions

During the previous meeting RAN1#116bis, different alternatives for network signaling were agreed for further down-selection. A summary of companies views regarding these alternatives together with benefits and drawbacks is provided below.

|  |  |  |
| --- | --- | --- |
| **Alternative** | **Benefits** | **Drawbacks** |
| **Alt 1: Dynamic indication**   * Support Alt 1: CMCC, DOCOMO, Ericsson, Google, Huawei, III, InterDigital, Lenovo, LG, MediaTek, Meta, NEC, Nokia, OPPO, Panasonic, Samsung, Sony, Spreadtrum, TCL, ZTE **(20)** * Support in combination: Fraunhofer (on top of Alt. 3) **(1)** * Do not support Alt 1: CATT, Qualcomm **(2)** | * Dynamic indication based solution is applicable regardless of XR traffic characteristic: **NTT DOCOMO** * Due to uncertainty in application packet arrival and size, as well as uncertainty in scheduling a transmission and/or its retransmission, a dynamic solution provides the network with the flexibility needed to improve XR capacity when a MG is required to enable UE measurements in a particular occasion or being skipped: **Ericsson** * Network can quickly react to changes in the channel/cell conditions: **Fraunhofer** * Low latency and fast delivery of the indication to skip the measurement gap: **Google** | * It requires the expected prediction of XR traffic arrival in the near future: **CATT** * No strong motivation to support on demand deactivation of measurement gap occasion(s) using DCIs with XR predictable traffic and small jitter: **Qualcomm** * Large specification effort: **Qualcomm** * Signaling overhead: **Qualcomm** * Timeline requirements: **Qualcomm, vivo, Fraunhofer** |
| **Sub-alternatives of Alt. 1:**  Alt 1.1   * Support: CMCC, DOCOMO, Ericsson, Google, InterDigital, Lenovo, MediaTek, NEC, Nokia, OPPO, Panasonic, Samsung, Sony, Spreadtrum, ZTE   + Lenovo: If the time offset is agreed to be large (e.g., larger than 2ms) * Do not support: CATT, Qualcomm   Alt. 1.2   * Support: Huawei, NEC, ZTE * Do not support: Ericsson, Nokia, CATT, Qualcomm   + Nokia: indication for multiple gap/restrictions is not needed   Alt. 1.3   * Support: Google, III, InterDigital, Lenovo, NEC, OPPO, TCL   + III: has less specification impact   + Lenovo: if time offset is agreed to be smaller (e.g., less than 2 ms) * Do not support: Ericsson, Nokia, ZTE, CATT, Qualcomm   + Ericsson: the least robust solution and can potentially results in additional delay in scheduling depending on the required timeline   + Nokia: reduced scheduling flexibility in the presence of the UE timeline constraint | | |
| **Alt. 2: Semi-persistent solution**   * Support Alt 2: Apple, CMCC, III, InterDigital, MediaTek, Qualcomm, Spreadtrum, Xiaomi, ZTE **(9)** * Support in combination:Ericsson (on top of Alt. 1-1), Fraunhofer (on top of Alt. 3), Panasonic (for CG/SPS), **(3)** * Do not support Alt 2: CATT, LG, Nokia **(3)** | * More flexible than the semi-static approach: **Fraunhofer** * Allow Tx/Rx of XR data over multiple gap/restriction occasions: **InterDigital** | * Additional signaling overhead to carry the activation and de-activation command without obvious advantage compared to the Alt 3: **CATT** * If XR traffic pattern can’t be matched well by pre-configured periodicity and offset, semi-persistent solution and semi-static solution may result in degraded RRM measurement performance without much improvement on XR capacity: **DOCOMO** * Semi-persistent solution will cause unnecessary signaling delay and inflexibility: **Huawei, Nokia** * No need to skip multiple MGs: **Samsung, Nokia** * Solution is not possible with an UL grant: **Samsung** * Timeline requirements: **Fraunhofer** * MAC-CE based signaling is slower than DCI-based solutions leading to longer timeline and also requiring to schedule a grant: **Nokia, Samsung** |
| **Sub-alternatives of Alt. 2:**  Alt. 2.1   * Support: InterDigital, Qualcomm, Xiaomi, ZTE * Do not support: CATT, LG, Nokia * Further study: Ericsson   + Ericsson: can be considered for further study if it is proven to be superior to Alt. 1-1 based solutions.   Alt. 2.1a   * Support: Ericsson, Xiaomi, ZTE * Do not support: CATT, LG, Nokia   Alt. 2.2   * Support: Apple, Qulacomm, ZTE * Do not support: Ericsson, CATT, LG, Nokia   + Ericsson: achieve the same goals as Alt. 2-1 with additional complexity   Alt. 2.3   * Support: CMCC, III, InterDigital, MediaTek, Spreadtrum * Do not support: Ericsson, CATT, LG, Nokia   + Ericsson: achieve the same goals as Alt. 2-1 with additional complexity | | |
| **Alt. 3: Semi-static solution**   * Support Alt 3: Apple, CATT, Fraunhofer, Google, Huawei, III, InterDigital, MediaTek, Qualcomm, Spreadtrum, TCL, vivo **(12)** * Support in combination: Nokia (on top of Alt. 1-1), Lenovo (for CG/SPS), OPPO (for CG/SPS), LG **(3)** * Do not support Alt 3: Ericsson, Samsung, ZTE **(3)** | * Well suited to periodic XR traffic: **Fraunhofer** * Processing timeline is less critical: **Fraunhofer, vivo** * No need for retransmission if command is not received or successfully decoded: **Fraunhofer** * Can account for the DRX: **Fraunhofer** * Limited signaling overhead, especially if the pattern is (pre-)configured: **Fraunhofer** * Can be applied for CG/SPS without additional signalling overhead: **OPPO, Panasonic** | * If XR traffic pattern can’t be matched well by pre-configured periodicity and offset, semi-persistent solution and semi-static solution may result in degraded RRM measurement performance without much improvement on XR capacity: **DOCOMO** * Due to the inbuilt uncertainty on the need for utilizing a MG for serving the traffic, determining a proper configuration/pattern/time window that meets the intended objectives is impractical and results in resource wastage and unnecessary complexity: **Ericsson** * When the network needs to modify the occasions of gaps/restrictions to be skipped, RRC reconfiguration is needed, which costs a relatively large delay: **CMCC** * Cannot be adapted to varying channel conditions: **Samsung** |
| **Sub-alternatives of Alt. 3:**  Alt. 3.1   * Support: Fraunhofer, Huawei, InterDigital, MediaTek, Nokia, Qualcomm, Spreadtrum, vivo * Do not support: Ericsson, Samsung, ZTE   Alt. 3.2   * Support: Apple * Do not support: Ericsson, Samsung, ZTE, Nokia   Alt. 3.3   * Support: CATT, Lenovo, LG, Nokia, OPPO, vivo * Do not support: Ericsson, Samsung, ZTE   Alt. 3.4   * Support: Google, III, Lenovo, LG, Qualcomm, TCL, vivo * Do not support: Ericsson, Samsung, ZTE * For further study: Nokia | | |
|  | | |
| **Combintaions of alternatives:**   * Alt.1-1 (baseline) + Alt. 2-1a: Ericsson * Alt. 1 + Alt 3-3/3-4 for semi-static/semi-persistent scheduling: Lenovo * Alt. 1-1 (baseline) + Alt 3-1/3-3: Nokia * Alt. 1 + Alt. 2: MediaTek, Panasonic * Alt. 3 (baseline) + Alt. 2-3: Fraunhofer * Alt. 3 (baseline) + Alt. 1.2: Fraunhofer | | |

Signaling details:

**Alt 1: Dynamic indication**

Alt. 1-1 Explicit indication by DCI to skip a particular gap(s)/restriction(s):

* DCI format
  + DCI format X\_1, X\_2 can be configured with gap/restriction cancellation indication field: Ericsson, MediaTek, Nokia, OPPO, Samsung, Spreadtrum, TCL
  + New DCI format: LG, Nokia
    - to minimize the impact on UE blind decoding, new DCI format should not be introduced: OPPO
* DCI content
  + New bitfield: Spreadtrum, ZTE, OPPO, Samsung
  + A bit(s) in the cancellation field is associated to a MG occasion(s) starting after the last symbol of the PDCCH carrying the DCI format and indicates whether the MG occasion(s) is cancelled: Ericsson
* Size of the new bitfield:
  + One bit: Samsung, OPPO
* Applicability
  + Applicable to the next measurement occasion: Nokia, Samsung, Spreadtrum, OPPO
* When a MG occasion is indicated cancelled, it should be remained cancelled: Ericsson
* The first cancellation indication should satisfy a timeline with respect to the cancelled MG occasion(s): Ericsson

Alt 1-2 Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s):

* DCI content:
  + DCI contains 1 or 2 bits to indicate one length of time window: Huawei
* RRC configuration:
  + 1 or more lengths of time window are configured by RRC: Huawei

Alt 1-3: Implicit indication by DCI scheduling a transmission/reception overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s):

* All legacy DCI formats (i.e. DCI format x-0/1/2/3) scheduling a PDSCH/PUSCH/PUCCH in a gap/restriction can indicate the skipping of the gap/restriction: OPPO

**Alt. 2: Semi-persistent solution**

A new PHY priority index should be introduced to CG/SPS configurations: Panasonic

Alt 2-1: gNB sends a skipping activation command, UE will skip gaps/restrictions until de-activation command is received:

* MAC-CE can deactivate gaps/restrictions; the activation of gaps with MAC-CE is not supported: Qualcomm

Alt 2-1a: gNB sends an activation command to enable pre-configured gap(s)/restriction(s), UE will skip gap(s)/restriction(s) after de-activation command is received:

* Operation 1 (baseline): Configured MGs are activated (Mode 1 or transition from Mode 2 to Mode 1). DCI indication can skip a MG occasion(s) for data TX/RX when needed: Ericsson
* Operation 2 (complementary): Configured MGs are deactivated (Mode 2 or transition from Mode 1 to Mode 2). DCI indication can activate a MG occasion(s) for RRM when needed: Ericsson

Alt. 2-2 RRM measurement adaptation is applied to all MG configurations/scheduling restrictions due to all SMTC configurations, or is applied to selected MG configuration(s) and/or scheduling restrictions due to selected SMTC configuration(s) and is conducted in a time-window, and time-windows are derived from a semi-persistent activation for their periodicity, offset and duration:

* A time-window period, a time-window offset, and time-window duration are provided to derive time windows: Apple
* Non-integer periodicity for periodic configuration/semi-persistent configuration targeting RRM measurement gap adaptation (skipping): Apple

Alt. 2-3 Activate/de-activate one or more of pre-configured pattern(s) via MAC-CE to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s):

* A time-domain pattern configuration to set higher priority for XR transmission/reception on the occasions indicated by the pattern and to allow RRM measurements on other occasions not indicated by the pattern: MediaTek
* MAC-CE activate one or more of pre-configured pattern(s) to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s): Spreadtrum
* A configured pattern includes usable information of MG/restriction occasions in a time window: Spreadtrum
* The time window is periodic with fix length: Spreadtrum
* Usable information of MG/restriction occasions in a time window can be indicated by activation MAC-CE: Spreadtrum

**Alt. 3: Semi-static solution**

Alt. 3-1 Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions:

* Starting position, periodicity and duration of the pattern, and a threshold are RRC configured: Huawei
  + If the overlapping ratio between the duration of pattern and the duration of RRM measurements is larger than the threshold, the RRM measurements are cancelled: Huawei
* a time-domain pattern configuration to set higher priority for XR transmission/reception on the occasions indicated by the pattern and to allow RRM measurements on other occasions not indicated by the pattern: MediaTek
* A configured pattern includes usable information of MG/restriction occasions: Spreadtrum

Alt. 3-2 Gaps/restrictions skipping is applied to all MG configurations/scheduling restrictions due to all SMTC configurations / RRM measurements, or is applied to selected MG configuration(s) and/or scheduling restrictions due to selected SMTC configuration(s) / RRM measurement(s) and is conducted in a time-window, and time-windows are derived from a semi-static configuration for their periodicity, offset and duration:

* A time-window period, a time-window offset, and time-window duration are provided to derive time windows: Apple
* Support non-integer periodicity for periodic configuration/semi-persistent configuration targeting RRM measurement gap adaptation (skipping): Apple

Alt. 3-3 Gaps/restrictions that are caused by RRM measurements are skipped if collided with particular semi-statically pre-configured Tx/Rx occasions:

* The “particular semi-statically pre-configured Tx/Rx occasions” in Alt 3-3 refers to the valid CG/SPS transmission occasions corresponding to a CG/SPS configuration that is configured to allow MG cancellation in case of overlaps in time with an occasion of measurement gaps/restrictions: OPPO

Alt. 3-4: Gaps/restrictions that are caused by RRM measurements are skipped based on semi-statically configured priority information for particular semi-statically pre-configured Tx/Rx and/or particular gaps/restrictions:

* The network can configure the UE with a priority threshold and the UE can check the priority of the data or the priority of the gap against the configured priority threshold: Google

### High priority discussion: Round #1

Moderator’s comments:

Note: Please, check the moderator’s summary of contributions for detailed information about each of the alternatives in Section 2.1.6.

It is important we converge to an alternative this meeting to continue developing details of the solution (choosing sub-alternative, addressing signalling details, etc.).

Based on companies' contributions Alt. 1 (dynamic indication) gained the most support: (i) Alt. 1 **(20)** (ii) Alt. 3 **(12)** (iii) Alt. 2 **(9).** Some companies also proposed to consider a combination of the alternatives and sub-alternatives.

The benefits and drawbacks of each alternative according to companies' views can be found above in Section 2.1.6.

It shall be noted that there are some contradictory comments, e.g., some companies consider no knowledge about traffic arrival while other consider this knowledge available (periodicity + jitter range).

For initial transmission, the periodicity + jitter range (let's call it window of potential traffic arrival) can give some estimate of when the XR traffic arrives. But it is not only the collision of this window of potential traffic arrival with measurement occasion that leads to packets being delayed and possibly exciding its PDB. Even if window of potential traffic arrival does not collide with measurement occasion, e.g., it ended before measurement occasion, transmission of packets takes more than one slot in many cases, thus some packets will still end up in measurement occasion thus dropped. And finally, there are re-transmissions of XR packets that cannot be predicted in advance.

Based on the comments above and summary in Section 2.1.6, moderator recommends converging to one alternative, e.g., to Alt. 1 as most supported solution, providing a range of benefits and well suited to the XR type of traffic. The following list of questions aims to facilitate this discussion further.

**Please, provide your view (in the table below) regarding the following questions:**

|  |
| --- |
| **Q1:** Please, indicate your preferred alternative from the agreement made in RAN1#116-bis (assuming we choose only one alternative):   * Option 1: Support Alt. 1 (dynamic indication). * Option 2: Support Alt. 2 (semi-persistent solution). * Option 3: Support Alt. 3 (semi-static solution).   **Q2**: Section 2.1.6 has a table with benefits and drawbacks for each solution based on contributions. Please, elaborate on advantages of the preferred alternative from Q1 over two other alternatives (e.g., extra benefits on top the Benefits in Section 2.1.6) as well as address the concerns related to your preferred alternative from “Drawback” column (Sec. 2.1.6).  **Q3:** In case you support a combination of sub-alternatives, please indicate your preferred combination with exact sub-alternatives from the agreement made in RAN1#116-bis (e.g., Alt. 3-1 (baseline) + Alt. 2-3). Explain the motivation and benefits of such a combination, why one solution is not enough, and highlight which sub-alternative is a baseline solution and which is a complementary solution, if possible. |

|  |  |
| --- | --- |
| **Company** | **Answers/Comments** |
| InterDigital | Q1: Option 1  Q2: In our view, assuming timeline and PDCCH monitoring occasions is properly addressed (e.g. DCI is received T slots/symbols before the start of a gap occasion), Alt. 1 provides sufficient flexibility to handle any issues related to jitter, payload size changes and ReTx. Although Alt. 2 and Alt. 3 may incur less signaling overhead, unless a particular pattern that is aligned with the traffic is used (Alt. 2-3, Alt. 3-1), it is unclear how any of the XR issues can be effectively addressed with Alts. 2 and 3.  Q3: Compared to any of the other combinations, we prefer the combination: Alt. 3-1 (baseline) + Alt. 2-3, with the pattern aligned with XR traffic periodicity+jitter. |
| ZTE, Sanechips | **Q1:** We support Alt. 1. And Alt 1 should be the baseline mechanism.  **Q2:**  Advantages of Alt. 1: Dynamic solution provides good flexibility to handle the abrupt collision between data transmission and gap/restriction. Since whether or not skip a gap/restriction can be indicated as per usage of each gap/restriction, it is also believed that dynamic solution ensures better balance between measurement performance and system capacity  For drawback of Alt1 mentioned by opponents:  1. From the perspective of the prediction of XR traffic arrival, we think it is difficult to predict XR traffic arrival in future. In the meanwhile, for a UE, there would be multiple configurations for gaps/restrictions. In this case, within one traffic periodicity, multiple gaps/restrictions from different gaps/restrictions might be overlapped with transmission/ reception of one packet. In this case, these overlapped occasions should be indicated in one signalling to be skipped.  2. Regarding the fixed pattern between traffic and measurement gap, we think there is no one fixed overlapped pattern, since the traffic arrives quasi-periodically with jitter. (This is also one serious concern to Alt 3).  3. As for the timeline of DCI signaling, DCI timeline requirement is shorter than MAC timeline requirement, since MAC CE signalling should be activated at the starting of transmitting HARQ-ACK.  4. For specification impact and limited RAN1 TUs, in our opinion, the effort of designing DCI signaling may be similar to that of MAC CE signaling, and coordination with RAN2 also takes extra time. |
| OPPO | Q2: To address the concerns for Alt 1-3:   * + Ericsson: the least robust solution and can potentially results in additional delay in scheduling depending on the required timeline   [OPPO]: We share different view for the argumenet of “least robust solution” for the following reason: 1) For Alt 1-3, the implicit indication depends on UE correctly reception of DCI and thus get the information of the time domain location of PDSCH/PUSCH. UE does not need to correctly decode PDSCH/PUSCH. Given the high reliability of DCI, we do not think this is least robust. Moreover, gNB can use conservative scheduling, e.g., higher AL for PDCCH scheduling, such that the reliability of PDCCH would be much higher.   * + Nokia: reduced scheduling flexibility in the presence of the UE timeline constraint   [OPPO]: We fail to see the “reduced scheduling flexibility”. If gNB decides to deactive one MG, it would anyway schedule some data in the MG, in such a case, Alt 1-3 is the pre-scheduling of that data.  Q3: we prefer Alt 1-1/1-3+Alt 3-3 to cover the cases of XR traffic scheduled by dynamic DCI and CG/SPS. |
| Lenovo | Q1: option 1  Q2: at least for DL, and maybe for tethered UL, the XR jitter may not be small; so having a dynamic indication can be useful.  Q3: depending on the time offset (Alt 1-1 or Alt 1-3) + Alt 3-3 (for SPS/CG). Alt 3-3 could save DCI overhead (when that’s an issue) if a CG/SPS is used to carry latency-critical data. |
| DOCOMO | Q1: Option 1. Considering only one solution is supported in the end, we think option 1 is with widest applicability.  Q2: We think the concern on specification impact and additional signaling overhead for option 1 depends on the detailed design. For example, if only 1 bit is used for the skipping indication, it would not be a big issue. |
| Qualcomm | Q1: we strongly object Option 1.  Q2: Among all the concerns against Option 1 mentioned by companies, we would like to highlight the implementation difficulty and specification efforts. To achieve the dynamic deactivation, generally a minimum 5ms delay is needed after the decoding of the DCI. This follows the existing feature of dynamic deactivation of preconfigured MGs. Companies also proposed to use other timeline as reference, but we think they are not as relevant to MG. Introducing 5ms scheduling offset does not make sense to XR video traffic. Also using a new DCI format, i.e., non-scheduling DCI has huge specification efforts, such as how to define the non-scheduling DCI formant and HARQ-ACK for the robust transmission of the DCI. We think it is a bad idea to introduce such a fundamental timeline impact to a late release of a generation. Maybe the dynamic mechanism of Option 1 can be deferred to 6G.  Q3: we do not support any combination that includes Option 1. |
| Xiaomi | Q1: Option 2  Q2: From our perspective, option 2 could be a trade off between option 1 and option 3. A command can be carried by MAC CE to skip or active the gap/restriction. |
| Huawei, HiSilicon | Q1: Option 3  Q2:  Alt 1’s main drawbacks are: 1) larger spec efforts, including desiging DCI, timeline issue (which may be discussed and decided by RAN4), etc.; 2) additional signalling overhead. E.g., CG will be used by XR UL and there is no DCI for initial transmission. Alt 1 leads to additional DCI.  Alt 3 does not have such issues.  XR traffic is periodic with small jitter. R18 SA2 already specified that CN will indicate jitter range to gNB in DL, and UE will report jitter range to gNB in UL. So gNB knows XR traffic periodicity and jitter range, and thus knows XR traffic arrival.  XR traffic arrival does not change frequently, so gNB does not need to update the RRC configuration frequently.  Althouh Alt 1 may be able to adapt to varying channel, this is at the cost of increased signalling overhead.  We do not support Alt2, which has unnessary signalling of activation/de-activation. |
| LG | Q1: We support Alt. 1 and Alt. 3 to cover the various cases of gap/restriction.  Q2:  In general, we think Alt. 2 is not applicable for aperiodic gap XR traffic. In addition, for p-a periodic traffic, Alt. 3 has more benefit for the case.  For the drawbacks listed in Alt. 1, they are already conflict with each other, regrading to whether the traffic are predictable. However, regardless of that, gNB can indicate gap/restriction with time duration for skipping more than one measurement gap, or utilize Alt.1-3 to indicate XR traffic to be prioritize.  For Alt. 3, all listed drawbacks are not applied to Alt. 3-3 and Alt. 3-4. By considering configured TX/RX, we can avoid to determining complicated pattern and a number of re-configurations.  Q3: We prefer Alt. 1 (for dynamic) + Alt. 3-3 or 3-4 (for semi-static) |
| Fraunhofer | Q1: Option 3.  Q2: Given the periodicity of the XR traffic, and the fact that the MG configuration are known, it is possible to identify the MGs conflicting with Tx/Rx.  Even if the RRC Reconfiguration comes at the cost of a relatively large delay, we can say that (a): it is not expected to occur very often, and (b): the constraints on the timeline are less strict than for dynamic signalling.  For the difficulty to determine a proper configuration/pattern/time window and o adapt to varying channel conditions, this is partly true. In ou view, the semi-static solution can be configured based on the long-term trends of the chanel conditions, and any shorter-term fluctuations can be instead addressed by dynamic signalling.  In addition, as a general concern for all the alternatives: what is the content of the activation/ deactivation command and to which types of MG occasions is it supposed to apply? Two options are indeed possible, i.e., the same bitmap is used for all the different MG configurations (Option 1), or one bitmap is used for each MG configuration (Optio 2). We think this may be taken into account to evaluate the complexity and feasibility of each alternative.  Q3: Alt. 3.1 (baseline) + Alt. 1.2 (or Alt. 2.3). The motivation is to have one relatively fixed solution (long-term) in combination with a more dynamic one to have he possibility to punctually deactivate/ reactivate specific MGs without using RRC Reconfiguration. |
| Spreadtrum | Our first preference is Alt 3.  For XR traffic, they are semi-periodic. So the overlapping condition with MGs can be configured by RRC signaling.  Second, considering the timeline might be long for a UE to adjust its MG occasions, such as Rel-17 disactivation of preconfigured MGs, DCI would be useless. |
| Panasonic | Q1: Option 1  Q2: Option 1 has a flexibility for the MG skipping indication, however, it would work well with dynamic scheduling. A complimentary solution is required for supporint SPS/CG.  Q3: We think the combination of Alt. 1-3 (baseline) and Alt. 3-3 is required to support MG skipping for both dynamic and semi-static schedulings. |
| CMCC | First preference is Alt 2.  Alt 2 is a comprmise between Alt 1 and Alt 3. Althuough the XR traffic is semi-periodic which may have a semi-static collision pattern with MG/SMTC, however, in the scheduling restriction case without MG case, whether there is scheduling restriction also depends on other conditions, such as mixed numerology between data and SCS, Thus Alt 2 is solution to provide more flexibility on the MG/SMTC skipping pattern indication. |
| Moderator | Summary:  Support Alt. 1: InterDigital, ZTE, Lenovo, DOCOMO, Panasonic   * Not ok: Qualcomm (timeline of 5ms assumed)   Support Alt. 2: Xiaomi, CMCC   * Not ok:   Support Alt. 3: Huawei, Fraunhofer, Spreadtrum   * Not ok:   Combination of alternatives:   * Alt. 3-1 (baseline) + Alt. 2-3: InterDigital * Alt 1-1/1-3+Alt 3-3 (for SPS/CG): OPPO, Lenovo, Panasonic (Alt. 1-3) * Alt. 1 (for dynamic) + Alt. 3-3 or 3-4 (for semi-static): LG * Alt. 3.1 (baseline) + Alt. 1.2 (or Alt. 2.3): Fraunhofer   @ALL: One of the concerns mentioned by companies for Alt. 1 and Alt. 2 is timeline requirement. While Alt. 3 shall not be dependant on such requirements. During offline, it is good to discuss whether this is an issue or timeline can be part of the solution.  For Alt. 2, companies concern is the additional signalling overhead with no clear benefits from it or de-activating the whole measurement configuration while only e.g., one measurement occasion need to be skipped.  For Alt. 3, companies concern is the pattern, how exactly to define it in advance (based on jitter range and periodicity only?), the solution will not be flexible to adapt to varying channel conditions.  Signalling overhead and specification impact will depend on particular solution chosen – it is applicable to all alternatives. |
| vivo | Q1: we support Option 3 and object Option 1.  Q2: for DCI based solution, the second Benefit is debatable. Since the jitter and packet side for XR traffic is unpredictable, only when the packets for XR are arrived, gNB will indicate UE to skip a gap occasion after a certain time offset. It the time offset for DCI based solution is large, e.g. 5.ms, the packets for XR can almost be scheduled within 5ms. The following figure shows our simulation result in previous relase for XR traffic under the assumption of InH, VR 30Mbps, 12UEs/Cell(maximum capability for XR, which means if there less UEs, the transmission delay will be smaller). For retransmssion, it is not reasonable for gNB to make the retransmission after 5ms. For the Drawbacks for DCI based solutions, UE implementation should also be included. In addition, the robustness aspect is also important, and the DCI miss dection issue should be considered.  Q3: we prefer Alt 3-1+Alt 3-3/3-4 to cover the cases of XR traffic scheduled by dynamic DCI and CG/SPS. |
| TCL | Q1: Option 1  Q2: Alt. 1 provides more flexibility to match the characteristics of XR services like jitter, vary packet size and any re-transmission a data, for a scheduling data transmission, a data transmission/reception is overlapped with measurement gap/restriction in time domain can be controlled by gNB, in addition, based on Alt1-3 will also have no additional signalling overhead.  Q3: We prefer Alt 1-1/1-3+Alt 3-4 to cover the cases of XR traffic scheduled by dynamic DCI and/or CG/SPS. |
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## Timeline discussion

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Apple | Proposal 7: the minimum time gap between the end of a PDCCH indicating time-window and the start of the time-window is non-zero; and its duration can be a UE capability. |
| CMCC | Proposal 2. For Alt. 1-1: Explicit indication by DCI to skip a particular gap/restriction, the DCI indication should satisfy a timeline requirement with respect to the indicated gap/restriction. |
| Ericsson | Proposal 6. For dynamic indication for cancellation of a MG (i.e. Alt. 1), support at least the following with respect to the cancellation timeline:  • Tproc1, Tproc2 or exiting UL cancellation timeline can be reused for duration of the MG cancellation timeline.  • The reference for the cancellation timeline is the start of the cancelled MG as the baseline.  • The cancellation timeline should only be satisfied for the first indication of a cancelled MG.  A screenshot of a video game  Description automatically generated  Figure 2: Illustration of dynamic indication of a MG cancellation. The indication is performed by a field in DCI where in this example, 1-bit is used to indicate the status of next MG (‘0’/’1’ corresponding to ‘not cancelled’/’cancelled’). The timeline is shown by Tm. Case 1 illustrates the basic operation without any cancellation. Case 2 illustrates the cancellation of upcoming MG. Case 3 illustrates the consistency in cancellation indication where reserving a cancellation is not allowed.  A screenshot of a computer  Description automatically generated  Figure 3: Cancellation timeline is applicable to the first cancellation indication. Once a MG is indicated cancelled by PDCCH1, PDCCH2 with cancellation indication can be received after the timeline and before the cancelled MG or within the cancelled MG. This PDCCH can schedule a transmission within the cancelled MG. |
| Fraunhofer | Proposal 2: Further study the impact of missing a retransmission of the MAC CE-based MG activation/ deactivation timeline.  Observation 3: The MG activation/deactivation MAC CE command must be received at most slots before the first MG to be deactivated. The activation/deactivation command takes effect in the first MG occasion after the completion of the event.  Proposal 5: Further study the impact of missing a retransmission of the DCI-based MG activation/ deactivation timeline.  Observation 5: The MG activation/deactivation DCI command must be received at most 5ms before the first MG to be deactivated. The activation/deactivation command takes effect in the first MG occasion after the completion of the event. |
| Huawei | Proposal 1: In Alt 1 (Dynamic indication), the time offset between the end of received dynamic indication and start of gap(s)/restriction(s) occasion that is going to be skipped shall be larger than X, e.g., X could be equal to PUSCH preparation time N2 as defined in Clause 6.4 of TS 38.214. RAN1 sends LS to RAN4, and ask RAN4 to decide the exact value of X.  *[From Clause 5.1.6.4 in TS 38.214]*  When the UE has an activated DL PRS processing window with *type1A* or *type1B* and the UE determines the presence of other DL signals and channels, except SSB, of higher priority than the DL PRS in the DL PRS processing window later than *N2* symbols, defined in clause 6.4 for the subcarrier spacing of the DL PRS, before the first symbol of the DL PRS processing window, the UE is not required to receive the other DL signals and channels and may receive the DL PRS and consider the DL PRS as higher priority in the DL PRS processing window. |
| Lenovo | Proposal 4: Determine the time offset value before deciding whether to support any related alternatives (Alt1, Alt2 variants).  Observation: The time offset for Alt 1 is likely less than the timeline for Rel-17 dynamic activation/deactivation of preconfigured measurement gaps upon DCI-based BWP switch specified in TS 38.133 clause 8.19.2; as in this work item, the measurement gaps have already been set up. |
| MediaTek | Proposal 9: If DCI-based dynamic indication is supported, the related discussion on minimum processing time value(s) shall be held as part of UE features discussion. |
| OPPO | Observation 3: The time offset between the end of DCI reception and the start of the skipped gap(s)/restriction(s) occasion needs to take into consideration the PDCCH decoding, PUSCH preparation and measurement re-planning.  Observation 4: The range of k1 (which is up to 15) and k0/k2 (which is up to 32) in current spec are large and flexible enough to cover the time offset between the end of dynamic indication reception and start of gap(s)/restriction(s) occasion that is to be skipped. |
| Qualcomm | Observation 4. The timeline is related to the minimum time after which it’s ­­not possible to cancel the retune and is not based on the UE processing timeline for PDSCH/PUSCH or UL cancellation timeline.  Proposal 6. The indication to deactivate a gap should satisfy a timeline requirement from the reference start of the first measurement gap occasion to be deactivated. The actual values of mg-offset are based on a UE capability.  Proposal 7. Reuse the timeline for Rel-17 dynamic deactivation of preconfigured measurement gaps and new timeline requirement is not introduced.  Proposal 8. Send an LS to RAN4 for triggering timeline discussion on deactivation of gap(s)/restriction(s) and assessing the feasibility of solutions identified by RAN1 for the timeline requirement.    Figure 1: Alt 1-3 DCI schedules PDSCH at least mg-offset from the last symbol of the PDCCH carrying the implicit deactivation indication. |
| Spreadtrum | Proposal 4: Consider a minimum time gap between the end of skipping command and the start of skipped measurement occasion, Rel-17 dynamic deactivation of preconfigured measurement gaps can be reused. |
| TCL | Proposal 4: Re-use the current processing timeline for PDSCH or PUSCH as the minimum time gap between the end of skipping command and the start of skipped measurement occasion. |
| Xiaomi | Observation3: It is crucial to allocate sufficient time prior to canceling/skipping specific gaps/restrictions and preparing for communication transmission.  Proposal 3：Timeline for solutions of enabling TX/RX for XR during RRM measurements should be discussed in RAN1. |
| ZTE | Proposal 8: RAN1 discusses two UE capabilities to accommodate both small and large time offsets.    Figure 8 Timeline consideration of dynamic signaling |

### Moderator's summary of contributions

During the previous meeting RAN1#116bis, different alternatives for network signaling were agreed for further down-selection together with FFS on timeline requirements for indication. A summary of companies views regarding timeline is summarized below.

**For dynamic indication (Alt. 1)**

Minimum time offset X between the end of received dynamic indication and start of gap(s)/restriction(s) occasion that is going to be skipped is:

* **Up to UE capability:** Apple, MediaTek, Qualcomm, ZTE
  + RRM measurements are highly related to UE implementation: MediaTek
  + The timeline requirement is to accommodate for the minimum time after which it’s not possible to cancel the retune: Qualcomm
* **Up to RAN4:** Huawei, Qualcomm
  + RAN4 is the right working group for the discussion on the timeline for measurement gap deactivation, send an LS to RAN4: Qualcomm
* **The following values were proposed:**
  + **Tproc1, Tproc2:** Ericsson, TCL
  + **Existing UL cancellation timeline:** Ericsson
  + **PUSCH preparation time N2 as defined in Clause 6.4 of TS 38.214:** Huawei
    - N2 as in R17 Positioning is used in the determination of the PRS measurements: Huawei
  + **Timeline for Rel-17 dynamic deactivation of preconfigured measurement gaps:** Qualcomm, Spreadtrum
    - The time offset is less than the timeline for Rel-17 dynamic activation/deactivation of preconfigured measurement gaps upon DCI-based BWP switch specified in TS 38.133 clause 8.19.2; as in this work item, the measurement gaps have already been set up: Lenovo
    - The activation and deactivation delays associated with the pre-Measurement Gap (pre-MG) is different from delays discussed in 9.10.1: ZTE

The cancellation timeline should only be satisfied for the first indication of a cancelled measurement occasion: Ericsson

**For semi-persistent solution (Alt. 2)**

MAC CE command must be received at most slots before the first MG to be deactivated: Fraunhofer

* is the slot index indicated for PUCCH transmission with HARQ-ACK information about the PDSCH (carrying the MAC CE) reception,
* is the corresponding timing (in milliseconds),
* is the number of slots per subframe for the SCS configuration of the PUCCH transmission.

### Medium priority discussion: Round #1

Moderator’s comment:

Note: Please, check the moderator’s summary of contributions for detailed information about timeline in Section 2.2.2.

According to contributions submitted to RAN1#117, there are different views related to timeline considerations for indication to skip measurement occasion. The views are summarized above. There are different values proposed for time offset. Some companies were referring to re-use value from Rel-17 dynamic deactivation of preconfigured measurement gaps, however other companies shared their concern about that, saying it is not the same scenario and such large time offset is not needed. Another company proposed to rely on PUSCH preparation time N2 as in R17 Positioning used in the determination of the PRS measurements.

Moderator recommends we first decide on the alternative to be supported for indication of skipping measurement occasion before making a decision on the timeline. However, it is good to have a discussion on the issue to understand companies view better.

**Please, provide your view (in the table below) regarding the following question:**

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| **Q1:** Please, share your view related to timeline for Alt. 1 and Alt. 2 and choose the option below. Please, elaborate your answer. In case there is an exact value that is proposed based on some reference, share why it is applicable to the scenario we are considering.   * **Option 1:** Minimum time offset X between indication to skip and skipped measurement occasion is up to UE capability and the value(s) is up to UE feature discussion; * **Option 2:** Minimum time offset X between indication to skip and skipped measurement occasion is up to RAN4 to discuss and decide; * **Option 3:** RAN1 to decide on the exact value for minimum time offset X between indication to skip and skipped measurement occasion. Please, share you view related to the value, e.g., minimum time offset X is:   + Tproc1, Tproc2;   + Existing UL cancellation timeline;   + PUSCH preparation time N2 as defined in Clause 6.4 of TS 38.214;   + Timeline for Rel-17 dynamic deactivation of preconfigured measurement gaps;   + Other value (indicate a value). * **Option 4:** No minimum time offset between indication to skip and skipped measurement occasion is needed. |

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| **Company** | **Answers/Comments** |
| InterDigital | In our view, this question can be addressed after some progress in the previous issue related to solutions. Nevertheless, we prefer Option 3, where the time offset can be discussed in RAN1 when disscusing the details of solution (e.g. Alt. 1) |
| ZTE, Sanechips | **Q1:**  We support Option 1. From our viewpoint, the activation and deactivation delays associated with the pre-Measurement Gap (pre-MG) require clarification. These delays should be clearly differentiated from the enhancements detailed in AI 9.10.1. But we do realize that time offset is important for different UEs, and some UEs should take account the largest time offset in the worst case. To this end, we propose to introduction of two distinct UE capabilities to accommodate both small and large time offsets. |
| Lenovo | Option 2; out of RAN1 expertise |
| Qualcomm | Regarding UE capability, we think if it is discussed, it should be only discussed for Option 2 solutions, e.g., there is a minimum time offset of 5ms from the MAC CE decoding to the fist MG to skip. For option 1, we do not think such a timeline justify the dynamic skipping of MGs anymore. At the end of the day, the timeline should be discussed by RAN4 before RAN1 makes any decision on a specific design or timeline. So we support **Option 2**. |
| Huawei, HiSilicon | Option 2. It is safer to let RAN4 discuss and decide on this. |
| LG | We support Option 2 since it is related to gNB/UE procedure for RRM measurement.  If Alt. 3 are only supported, Option 4 may be appropriate. |
| Fraunhofer | Alt. 1: It shall be noted that the jitter impacts not only the window of potential XR traffic arrival but also the DCI transmission. Hence, Option 3 may be the most appropriate to specify the minimum time offset gap X. The 5 ms value is sufficiently large to accommodate the range of the jitter and thus to ensure that the DCI is effectively received before the MG occasion that must be deactivated. This comes however at the cost of early signaling, raising questions on the relevance of, e..g, the UE assistance information based on which the dynamic signalling is triggered. For that reason, we think dynamic signalling should only be used in combination with another baseline solution (semi-static).  Alternatively, we are also fine with Option 2. |
| Spreadtrum | Option 2. |
| Moderator | Summary:  Option 1 (up to UE capability and UE feature discussion):  Option 2 (up to RAN4 to discuss): Lenovo (not RAN1 discussion), Qualcomm, Huawei, LG, Fraunhofer, Spreadtrum  Option 3 (RAN1 to discuss and decide): InterDigital (discuss after progress on solution)  Option 4:  @ALL: This discussion will be partly included into the discussion on alternatives. Based on companies views so far, it seems that this shall be up to RAN4 to discuss and decide if applicable to the chosen solution. |
| vivo | We think the timeline is important for DCI and MAC CE based solution, because whether DCI based solution is benifical depends on the timeline. But unfortunately, we don’t think RAN1 has the expertise to make the final decision. Tproc1, Tproc2, or UL cancellation timeline is the timeline for other cases which is different from RRM measurement cancellation, the precedent to change the state of a gap is Rel-17 dynamic deactivation of preconfigured measurement gaps, so we think the time for Rel-17 dynamic deactivation of preconfigured measurement gaps should be used. |
| TCL | We prefer Option 3, the timeline is closely related for Alt1 and Alt2, thus, we think the time offset can be discussed in RAN1. |
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## UE assistance information

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Apple | Proposal 8: a UE may provide assistance information to NW to facilitate enabling Tx/Rx for XR. |
| CMCC | Proposal 3. Support to introduce new UE assistance information for solution(s) to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements. At least consider the following UE assistance information related to measurement occasions:   * The maximum number of MGs/SMTC with restrictions that can be skipped within a time period.   Proposal 4. Regarding how/when UE reporting of measurement information, consider the following two options:   * Option 1: Triggered by the network request. * Option 2: Based on pre-defined conditions. |
| NTT DOCOMO | Proposal 3: New UE assistance information to enable Tx/Rx in gaps/restriction is not considered in RAN1. |
| Ericsson | Observation 8 . If the UE assistance information is supported, its availability should provide significant capacity improvement.  Observation 9 . UE assistance information related to measurement occasion needs further study.  Observation 10. The statistical UE assistance information related to channel conditions, mobility and XR traffic are already widely available and no further information is needed from RAN1 perspective.  (TS38.133) Table 9.2.5.2-1: Measurement period for intra-frequency measurements without gaps (FR1)   |  |  | | --- | --- | | DRX cycle | T SSB\_measurement\_period\_intra | | No DRX | max(200ms, ceil( 5 x Kp) x SMTC period)Note 1 x CSSFintra |   (TS38.133) Table 9.3.5-1: Measurement period for inter-frequency measurements with gaps (Frequency FR1)   |  |  | | --- | --- | | **Condition NOTE1,2** | **T SSB\_measurement\_period\_inter** | | No DRX | Max(200ms, Ceil(8 \* Kgap)  Max(MGRP, SMTC period))  CSSFinter | |
| Fraunhofer | Proposal 8: The measurement results provided by the UE to gNB may be used to facilitate Tx/Rx of XR traffic in MGs/restrictions that are caused by RRM measurements. Aperiodic measurement reporting may be introduced for that purpose, which would be triggered only when some conditions on the measurements are fulfilled.  Proposal 9: The RRM-related UE assistance information provided to gNB can include the prediction of the channel conditions (e.g., RSRP, RSRQ, and SINR) over the upcoming MGs/restrictions that are caused by RRM measurements.  Proposal 10: RRM measurements prediction can be used by the UE in MGs/restrictions which have been deactivated to enable transmissions/receptions for XR traffic instead of performing the actual measurements.  Proposal 11: UE assistance information related to traffic and UE mobility can be provided to gNB are up to RAN2 and should therefore not be discussed in RAN1.  Proposal 12: UE assistance information related to MGs can be provided to gNB are up to RAN2 and should therefore not be discussed in RAN1.  Proposal 13: The UE can use either UL MAC CE signaling or RRC signaling to provide the assistance information to the network.  Observation 7: The UE assistance information is not expected to be updated frequently and shall also remain applicable until the next update by the UE. Whether it can support dynamic indication solutions remains therefore doubtful. |
| Google | Proposal 5: The UE to report assistance information related to channel conditions, e.g. whenever L1 RSRP values fall below a configured threshold  Proposal 6: The UE to report number of measurement gaps that can be skipped within a specified/configured window  Proposal 7: The UE to report assistance information related to traffic, e.g., the priority of buffered UL traffic. Send LS to RAN2 to trigger this discussion.  Proposal 8: The UE reporting of assistance information can be done via semi-static signalling (e.g., RRC) or dynamic signalling ( e.g., via UCI, MAC-CE, …). It can be periodic, aperiodic (e.g., triggered by network), or based on triggering rules. Different assistance information can have different reporting methods. |
| Huawei | Observation 1: Report assistance information related to channel conditions, traffic and UE mobility alone, is not enough for the gNB to make accurate decision.  Proposal 3: UE reports assistance information periodically to gNB through MAC CE, and the assistance information contains a bitmap to indicate which of the subsequent gap(s)/restriction(s) can be skipped or not. |
| InterDigital | Proposal 1: RAN1 to deprioritize introducing new UE assistance information to enable Tx/Rx in gaps/restrictions |
| Lenovo | Proposal 5: The benefit of a new UAI should be justified by analyzing its effectiveness against existing mechanisms (e.g., RSRP/RSRQ-related reports, as well as BSR/DSR procedures), and such analysis seems to be out of RAN1 scope. |
| LG | Proposal 7: Do not introduce new UE assistance information for solution(s) to enable Tx/Rx in gaps/restrictions, at least from the RAN1 perspective |
| MediaTek | Proposal 3: Support UE indication to assist the network in determining the set of measurement occasions where skipping is feasible or acceptable. |
| Meta | Proposal 2: For the network signaling based solutions, support UE assistance information as part of the solution. |
| Nokia | Observation 4: In order to attain the benefits to the XR traffic the skipping needs to be determined (by network) based on the XR traffic needs. Any implications to RRM measurement performance should be considered in RAN4.  Observation 5: In attempt to predict the importance of future measurement occasion(s), UE would need to rely on past measurement results of the target cell/layer. Network equipped with reported measurement results, event based or periodic, can also be aware of the corresponding metrics, and predict the impact of measurement skipping.  Observation 6: Network can configure UE with various measurement reporting schemes, enabling network to have a good picture of the prevailing channel conditions of the UE. UE behavioral changes e.g. related to certain configured thresholds would seem suited more to RAN2 scope.  Observation 7: In light of past agreements and discussions e.g. in RAN2, RAN1 does not appear to be a correct forum to discuss traffic related assistance information  Observation 8: Network can configure UE with various measurement reporting schemes, enabling network to have a good picture of the UE mobility.  Proposal 9: RAN1 does not further consider the UE assistance information related to measurement occasions. It is expected that RAN4 will address the measurement performance impact of measurement occasion skipping.  Proposal 10: RAN1 does not further consider the UE assistance information related to channel conditions.  Proposal 11: RAN1 does not further consider the UE assistance information related to traffic.  Proposal 12: RAN1 does not further consider the UE assistance information related to UE mobility. |
| OPPO | Observation 1: In current RAN4 specification, the measurement delay is enlarged when the measurement resources is not available due to collision handling between concurrent measurement gaps or LBT failure.  Observation 2: If UE assistance information is supported, UE can provide information about measurements in the past (i.e., within a time period before reporting), but cannot be required to make safe predictions on the future factors to ensure qualified RRM measurements. |
| Qualcomm | Observation 5. The network already has sufficient information about the RSRP/RSRQ, mobility status and the delay status.  Observation 6. A UE may provide assistance information to the network to facilitate enabling Tx/Rx for XR. The network then decides on the deactivation pattern.  Proposal 9. UE assistance information to enable Tx/Rx in gaps/restrictions consists of:   * Alt 1: The maximum number of gaps that can be skipped within a time period. * Alt 2: Skipping pattern within a time period. |
| Samsung | Proposal 2: New UE assistance information is not supported for the purpose of gNB indication to a UE for the UE to skip a next MG. |
| Sony | Observation 1: UE has better knowledge, particularly for the UL traffic. Hence, UE assistance information could be beneficial in assisting gNB to allow XR traffic when there is a collision between XR traffic and RRM measurement.  Observation 2: : Skipping RRM measurement may affect the quality of the reported RRM measurement. It would be beneficial for gNB to know whether the RRM measurement has been compromised or not.  Proposal 6: Support UE assistance information indicating the number of gap(s) / restriction(s) that can be skipped during a configured RRM measurement. |
| Spreadtrum | Proposal 5: Introduce one-shot new UE assistance information for solution(s) to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements. At least the following UE assistance information related to measurement occasions are considered for further discussion:   1. The number of needed measurement gaps/SMTC with restrictions within a time period; 2. The number of consecutive RRM measurements that can be skipped; |
| TCL | Proposal 6：UE assistance information/indication to notify gNB whether enabling Tx/Rx for XR during RRM measurements restriction can be considered. |
| vivo | Observation 1: RRM-related UE assistance information is crucial to facilitate gNB to make proper decision on enabling transmissions/receptions for XR traffic in gaps/restrictions that are caused by RRM measurements.  Proposal 1: To facilitate gNB indication on enabling transmissions/receptions for XR traffic in gaps/restrictions that are caused by RRM measurements, the following UE assistance information are supported:   * Option 1: Pattern(s) of gap/restriction occasions that can be skipped. * Option 2: The maximum number or ratio of gap/restriction occasions within a time period that can be skipped.   Proposal 2: UE assistance information related to measurement occasions can be transmitted via RRC signalling.    Figure 1. Example for collision between XR traffic delivery and MG occasions  Figure 1. Example for collision between XR traffic delivery and MG occasions  Table 1. Evaluation assumptions   |  | | --- | | Basic assumptions | | SSB burst period = 20ms | | Measurement period = 80ms, Measurement GAP = 6ms | | XR traffic period = 16.67ms (60FPS), jitter range [-4, 4]ms, PER = 1% | | 98% packet transmission time ≤6ms, 50% packet transmission time ≤2ms (InH, VR 30Mbps, 12UEs/Cell) |   Table 2. Analysis of affected XR packets and MG occasions due to collision   |  |  |  | | --- | --- | --- | | Evaluation assumptions | Affected XR packets if no MG occasions are skipped | Affected measurement gaps occasions if all occasions overlapped with XR traffic transmission are kipped | | XR packet transmission time = 2ms, without jitter | 8% | 40% | | XR packet transmission time = 6ms, without jitter | 16% | 60% | | XR packet transmission time = 2ms, with jitter | 16% | 80% | | XR packet transmission time = 6ms, with jitter | 20% | 100% | |
| Xiaomi | Proposal 4：RAN1 should focus on the discussion for UE assistance information related to measurement occasions. Whether/How to support the UE assistance information related to channel conditions, traffic and UE mobility could be discussed in RAN2. |
| ZTE | Proposal 10: Extend the feature of reporting L3 parameters related to mobility to XR devices in Rel-19.  Proposal 11: The assistance information can be reported by User Assistance Information. |

### Moderator's summary of contributions

During the previous meeting RAN1#116bis, different UE assistance information was selected for further study. A number of companies expressed their view on UE assistance information. The views are summarized below.

**UE assistance information related to measurement occasions:**

* Provide information about the maximum number of MGs/SMTC with restrictions that can be skipped within a time period: **CMCC, Google, Qualcomm, Sony, Spreadtrum, vivo** (or ratio)
  + UE can derive this information by checking the margin of RRM measurements versus the RRM requirements and taking into consideration its implementation aspects: Google
  + RRM measurement is up to UE’s implementation, gNB does not have the information on gaps/restrictions used by UE for RRM measurement: Spreadtrum, vivo
  + The gNB needs to make good balance between RRM performance and XR service impact: vivo
  + **Concern:** The measurement delay requirement has already defined in RAN4 spec. TS 38.133 which can be used to understand how many samples UE is needed to perform the measurement: Ericsson
* Provide information about the patterns of gap(s)/restriction(s) where skipping is feasible or acceptable: **MediaTek, Qualcomm, vivo, Huawei**
  + UE needs to satisfy measurement requirements by taking measurements on sufficient number of occasions with good accuracy: MediaTek
  + **Concern:** De-prioritize, UE has no knowledge of the DL scheduling decision at the network side, it is not reasonable for UE to report the patterns of gaps/restrictions where skipping is feasible: CMCC
  + **Concern:** Traffic arrival does correlate with the pattern that UE indicates as feasible or acceptable to be skipped, the information does not help to improve capacity: Nokia
* Provide information about the number of consecutive RRM measurements that can be skipped: **Spreadtrum**
* Notify gNB whether enabling Tx/Rx for XR during RRM measurements restriction can be considered: **TCL**
* Further study UE assistance information related to measurement occasions: **Ericsson**
* RAN1 does not further consider the UE assistance information related to measurement occasions: **DOCOMO, InterDigital, Lenovo, LG, Nokia, Samsung**
  + **Concern**: Future channel conditions is not known to UE: Samsung, Nokia
  + **Concern:** There is no rule on how UE determines the information (e.g. the number of needed gaps, the maximum number or ratio of gaps to be skipped, etc.), the reported information may be not reliable: DOCOMO
  + **Concern:** RAN4 is responsible to consider the RRM measurement performance impact from measurement occasion skipping: Nokia
  + **Concern**: gNB can expect whether the UE needs RRM measurements through existing information provided by the UE, such as RSRP/RSRQ and BSR: LG

**UE assistance information related to channel conditions:**

* UE to report assistance information related to channel conditions: **Google**
  + Report an indication to the network whenever L1 RSRP values fall below a configured threshold: Google
  + **Concern:** The network already has sufficient information about the RSRP/RSRQ: Qualcomm, Samsung, Ericsson
* The prediction of the channel conditions (e.g., RSRP, RSRQ, and SINR) over the upcoming MGs/restrictions that are caused by RRM measurements: **Fraunhofer**
  + RRM measurements prediction can be used by the UE in MGs/restrictions which have been deactivated to enable transmissions/receptions for XR traffic instead of performing the actual measurements: Fraunhofer
* RAN1 does not further consider the UE assistance information related to channel conditions: **DOCOMO, InterDigital, Lenovo, LG, Nokia, Samsung, Ericsson**
  + **Concern**: It is up to RAN2 to discuss not RAN1: Xiaomi, Nokia
  + **Concern**: The benefit of a new UAI should be justified by analyzing its effectiveness against existing mechanisms (e.g., RSRP/RSRQ-related reports, as well as BSR/DSR procedures), and such analysis seems to be out of RAN1 scope: Lenovo, LG

**UE assistance information related to traffic:**

* RAN1 does not further consider the UE assistance information related to traffic: **DOCOMO, InterDigital, Lenovo, LG, Nokia, Samsung, Ericsson, Fraunhofer**
  + **Concern**: The network already has sufficient information about the delay status: Qualcomm, Samsung, Ericsson
  + **Concern**: Up to RAN2 to discuss: Xiaomi, Nokia, Fraunhofer
  + **Concern**: The benefit of a new UAI should be justified by analyzing its effectiveness against existing mechanisms (e.g., RSRP/RSRQ-related reports, as well as BSR/DSR procedures), and such analysis seems to be out of RAN1 scope: Lenovo, LG
  + **Concern**: PSI information is not possible to be signaled by RRC since it varies in every PDU set: Ericsson

**UE assistance information related to UE mobility:**

* Extend the feature of reporting L3 parameters related to mobility to XR devices: **ZTE**
* RAN1 does not further consider the UE assistance information related to UE mobility: **DOCOMO, InterDigital, Lenovo, LG, Nokia, Samsung, Ericsson, Fraunhofer**
  + **Concern**: Up to RAN2 to discuss: Xiaomi, Nokia, Fraunhofer
  + **Concern**: The network already has sufficient information about the mobility status: Qualcomm, Samsung, Ericsson
  + **Concern**: The benefit of a new UAI should be justified by analyzing its effectiveness against existing mechanisms (e.g., RSRP/RSRQ-related reports, as well as BSR/DSR procedures), and such analysis seems to be out of RAN1 scope: Lenovo, LG

UE assistance information support in general: **Apple, Meta**

### High priority discussion: Round #1

Moderator’s comments:

Note: Please, check the moderator’s summary of contributions for detailed information about UE assistance information based on Tdocs in Section 2.3.2.

According to companies contributions, only few companies expressed their support for the following UE assistance information to be considered in RAN1: **channel conditions, traffic, UE mobility**. A number of companies expressed their concern that a lot of information is already available and gains from additional information is not clear, some other companies commented that it is RAN2 domain and thus shall be studied there if needed. Thereby, given a large opposition and very minor support, moderator recommends not to consider this information in RAN1.

More companies expressed their support to UE assistance information related to **measurement occasions**. However, a lot of companies also raised concerns regarding introducing this additional information. Moderator recommends we further discuss UE assistance information related to measurement occasions in terms of benefits, concerns, etc.

It shall be noted that, in RAN1#117, RAN1 will make decision on the support of UE assistance information as per agreement from RAN1#116-bis. The questions below aim to facilitate the discussion.

**Please, provide your view (in the table below) regarding the following questions:**

|  |
| --- |
| **Q1:** Do you agree with the following proposal below? If not, please share an alternative and try addressing concerns from companies captured in Section .2.3.2 (marked as **Concern**). Please, elaborate your answer.  Proposal 2.3.1-v1  RAN1 does not further discuss new UE assistance information related to channel conditions, traffic, UE mobility.  **Q2:** Do you support UE assistance information related to measurement occasion?   * If yes, please indicate particular information you support; how exactly it benefits capacity while taking into account RRM measurement requirements (given that there is no mandated gNB behavior in response to any of the UE assistance information as per agreement in RAN1#116-bis)? Additionally, please address concerns raised by companies captured in Section 2.3.2 (marked as **Concern**) * If no, please elaborate your answer, share your concerns if not already captured in Section 2.3.2 (marked as **Concern**) |

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| --- | --- |
| **Company** | **Answers/Comments** |
| InterDigital | Support Proposal 2.3.1-v1 |
| ZTE, Sanechips | **Q1**: We consider to reuse the mechanism of relaxing RRM measurement for stationary Redcap UE where gNB understands that UE is in static state and may cancel measurement. With similar criteria and legacy report, in this special case (for stationary XR UE), gNB can indicate to skip the measurement gaps/restrictions.  Moreover, from our perspective, we are fine to agree further discuss this in RAN2 group. |
| OPPO | Support Proposal 2.3.1-v1 |
| Lenovo | Q1: Agree |
| DOCOMO | Support Proposal 2.3.1-v1. |
| Qualcomm | Q1: Support the proposal.  Q2: Yes. Looking at companies’ concerns, we see a main one that the UE may not know how to determine the future conditions. It should be clarified that the UE assistance information should be based on medium to long term statistics of channel conditions, traffic etc. In this sense, the UE assistance information could be based on recent history that will continue for a while and it does not provide useful information to network. As agreed in last meeting, network is not mandated to exactly follows the UE assistance information. |
| Xiaomi | Fine with the proposal 2.3.1-v1. Whether these UE assistance information could be supported based on RAN2’s discussion. |
| Huawei, HiSilicon | Q1: Support proposal.  Q2: support UE provides information about the patterns of gap(s)/restriction(s) where skipping is feasible or acceptable. Then, gNB can schedule accordingly. gNB still has the flexibility on scheduling. |
| LG | Q1: Support.  Q2: No. we are not sure how UE reports a new information and how utilize it. The information may be beneficial when the traffic is arrived, gap exists, and RRM measurement is needed. Neither gNB nor UE can know those three information. In this result, the consequence is redundant UE reports or static information based on rough UE prediction without any mandated gNB behavior. |
| Fraunhofer | Q1: Agree, but only for traffic and mobility (which are up to RAN2 to discuss). However, as we noted in our tdoc, the channel conditions can be used in two different ways, i.e.,:   * To predict the channel conditions (e.g., RSRP, RSRQ, and SINR) over the upcoming MGs. The MGs where the predicted channel conditions are sufficiently good can be deactivated in order to enable Tx/Rx for XR traffic, * To be used by the UE in MGs which have been deactivated to enable Tx/Rx for XR traffic instead of performing the actual measurements. This allows to further increase the number of MGs which can be deactivated while minimizing the impact on the performance requirements.   Q2: The UE assistance information related to measurement occasions should be discussed by RAN4 as the rules to decide which MG can be deactivated/skipped or not will have an impact on the RRM performance. |
| Spreadtrum | Q1: support |
| CMCC | Q1: agree  Q2: The measurement behavior is up to the UE implementation/capability and the network has no knowledge about the UE capability of measurement, such as number of SMCT UE needs. With the UE assistance information related to measurement, the network can make reasonable decisions to trigger/enable Tx/Rx in MGs/SMTC with restrictions without severely impacting the RRM measurement performance. |
| Moderator | Summary:  UE assistance information related to:  Measurement occasions:   * Support: Qualcomm * the patterns of gap(s)/restriction(s) where skipping is feasible or acceptable: Huawei * Not ok: LG, Fraunhofer (up to RAN4)   Channel conditions:  Support: Fraunhofer  Not ok:  Traffic:  Support:  Not ok:  Mobility:  Support: ZTE (ok to discuss this in RAN2 group)  Not ok:  Support Proposal 2.3.1-v1 : InterDigital, OPPO, Lenovo, DOCOMO, Qualcomm, Xiaomi, Huawei, LG, Spreadtrum, CMCC  Support for traffic and mobility information only: Fraunhofer  @ALL: based on the summary above, majority supports Proposal 2.3.1-v1.  UE assistance information related to measurements need more discussions, addressing the concerns, explaining benefits, etc. |
| vivo | Q1: Support the proposal.  Q2: Yes. Regarding the concerns from other companies, we try to answer from vivo’s understanding.   * **Concern:** The measurement delay requirement has already defined in RAN4 spec. TS 38.133 which can be used to understand how many samples UE is needed to perform the measurement: Ericsson   + [vivo]: the TS 38.133 define the Measurement period for intra/iner-frequency measurements,which can be used to understand the maximum samples UE is needed to perform the measurement, not the minimum samples, and the TS 38.133 is defined the period common for all UEs which consider the least capable UE. For UAI, it is UE-specific and is the minimum required gaps for RRM measurement. * **Concern:** De-prioritize, UE has no knowledge of the DL scheduling decision at the network side, it is not reasonable for UE to report the patterns of gaps/restrictions where skipping is feasible: CMCC   + [vivo]: agree that for DL traffic, UE does not has the knowledge of DL scheduling decision, it should also note that UE reports a pattern of gap(s)/restriction(s) where skipping is feasible or acceptable is not the final decision, the final desion is up to gNB, gNB has the information about XR traffic damend and UAI is some information for RRM measurement, so gNB can make better balace between XR traffic and RRM measurement impact. * **Concern:** Traffic arrival does correlate with the pattern that UE indicates as feasible or acceptable to be skipped, the information does not help to improve capacity: Nokia   + [vivo]: in the case given by Nokia, there are two demands, to deliver XR packet or to perform RRM measurement, and only one can survive. It is up to gNB to decide which one is prioritized. gNB can temporarily indicate UE to skip the gaps but gNB should be aware that there is risk that the RRM performance may be impacted. Although XR traffic is important, but RRM measurement is also essential for UE to keep connection with gNB. Without RRM measurement, the adverse impact for XR traffic will drastically. * **Concern**: Future channel conditions is not known to UE: Samsung, Nokia   + [vivo]: For the typical use cases for XR, the mobiliy for UE is small and the channel conditions will not change quickly. This is something like CSI, which is measured based on previous channel conditions, but it does not mean it can’t be applied in the furture. If the channel conditions changes very frequently, in that case, that means RRM measurement is quite important and it may not a good case for gNB to indicate UE to skip gaps for XR transmission. * **Concern:** There is no rule on how UE determines the information (e.g. the number of needed gaps, the maximum number or ratio of gaps to be skipped, etc.), the reported information may be not reliable: DOCOMO   + [vivo]: If UE supports this feauture of enabling Tx/Rx within gaps/restrictions, UE will determine the UE UAI reasonally, e.g. from the need of RRM measurement perspective. UE will not report that I need all gaps for measurement, otherwise, UE can report I don’t support this feature at all. * **Concern:** RAN4 is responsible to consider the RRM measurement performance impact from measurement occasion skipping: Nokia   + Again, it is meaningless to consider only the need of XR traffic without any consideration on RRM impact. Without UAI, gNB may need to make conservative decision to skip less gaps, otherwise, it may bring significant adverse impact on RRM. * **Concern**: gNB can expect whether the UE needs RRM measurements through existing information provided by the UE, such as RSRP/RSRQ and BSR: LG   + [vivo]: based on current information, gNB can only figure out whether UE has data to transmit or whether UE needs to perform RRM measurement. In the case UE needs to perform RRM measurements, gNB does not know how may samples, or which occasions are needed for UE to take samples, because currently, it is up to UE implementation. The spec only specify the requirements and it is up to UE to decide how to perform RRM measurement, only UE knows how to do can use the minimum occasions to satify the requirement. |
| TCL | Q1: Support  Q2: Yes, supporting UE provides information to notify gNB whether M-gap/restriction can be skipped or not. For UL service, gNB may not know the actual size and delay budget for a packet if UE not report the BSR timely, in addition, when the CG configuration is used for XR services, and the CG configuration is located within a RRM measurement gap/SMTC, with this case, it’s very difficult for gNB to make any decision. Thus, we think UE assistance information to notify gNB whether Tx/Rx need to perform within RRM measurement gap/restriction is necessary. |
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## Other types of solutions

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Google | Proposal 3: For a configured grant transmission, skip a measurement gap depending on the remaining delay budget for the transmission. |
| MediaTek | Proposal 2: Consider UE-triggering based solutions for measurement occasion skipping. At least, UE triggering solutions should be considered based on measurement report triggering on the condition that serving cell measurements are below or above a threshold (e.g., event-A2). |
| Xiaomi | Proposal 6：Support to further discuss the UE reporting based solutions for enabling TX/RX for XR during RRM measurements |

### Moderator's summary of contributions

The views related to additional solutions to enable Tx/Rx in gaps/restrictions caused by RRM measurements are summarised below.

**Consider UE-triggering based solutions for measurement occasion skipping: MediaTek, Google (for CG), Xiaomi:**

* UE assesses whether the remaining transmission time is larger than the configured delay threshold: Google
* UE triggering solutions should be considered based on measurement report triggering on the condition that serving cell measurements are below or above a threshold (e.g., event-A2): MediaTek

### Low priority discussion: Round #1

Moderator’s comment:

There were few contributions supporting other types of solutions beyond solutions based on network signaling to indicate skipped measurement occasion. According to moderator’s view, some of the alternatives from network signaling solutions may be able to solve the issue with e.g., CG PUSCH and thus the decision on the solution based on network signaling is needed to decide whether something extra is required.

Moderator’s recommendation:

The discussion on network-controlled solutions is still ongoing, thus it is recommended that RAN1 focuses on solutions based on network signaling and downselects the preferred scheme(s) before assessing whether additional solutions are needed.

**Please, provide your view (in the table below) regarding the following question:**

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| --- |
| **Q1:** Do you agree with moderator’s recommendation above? If you do not agree, please elaborate on an alternative way forward. |

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| **Company** | **Answers/Comments** |
| Lenovo | Yes |
| Qualcomm | Q1: support Moderator’s recommendation. |
| Huawei, HiSilicon | Support FL’s view. |
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## Partial skipping

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| CATT | Proposal 5: The partial cancellation/skipping the RRM measurement occasions should not be supported in Rel-19 RRM measurement enhancement. |
| NTT DOCOMO | Proposal 4: Not support the case where an occasion of gap/restrictions caused by RRM measurements are can-celled/skipped partially. |
| Ericsson | Proposal 7 . Postpone (but not de-prioritize) discussion on partial cancellation until the baseline design has achieved a good progress. Consider the support of partial cancellation if it can be accommodated as a simple extension of the baseline design.  A screenshot of a computer screen  Description automatically generated  Figure 4: Illustration of partial cancellation of a MG as compared to baseline cancellation. In case of partial cancellation, the reference point for the cancellation timeline is advanced within the MG with a duration potentially different than the one for baseline cancellation. |
| InterDigital | Proposal 5: Support partial skipping of occasions of gaps/restrictions |
| LG | Proposal 6: Support slot-level cancelling/skipping gaps/restrictions that are caused by RRM measurements to enable Tx/Rx |
| MediaTek | Proposal 4: Whether partial skipping is supported or not should be discussed at a later stage after some progress is achieved on full skipping as the baseline solution. |
| OPPO | Proposal 3: It is not supported in R19 XR to partially cancel/skip an occasion of gaps/restrictions caused by RRM measurements. |
| Sony | Proposal 5: Support partial skipping of gap(s)/restriction(s) to allow more scheduling opportunities. |
| TCL | Proposal 3. Partial slots/symbols within measurement restrictions for data transmission/reception can be considered. |
| Xiaomi | Observation1：The scheduling of UEs with higher capabilities can be expedited as they are able to complete their RRM measurements earlier.  Observation2：The enhancement of system scheduling efficiency can be achieved by effectively reducing the idle time of UEs caused by RRM measurement, particularly in scenarios with low system resource occupancy rate.  Proposal 1：Relevant reporting and processing mechanisms for mitigating UEs idle time caused by RRM measurements could be deliberated in RAN1, if deemed necessary.  Proposal 2：Partial cancellation or skipping of gaps or restrictions caused by RRM measurements could be futher discussed, if deemed necessary. |
| ZTE | Proposal 9: RAN1 continues to discuss the case where an occasion(s) of gap/restrictions that are caused by RRM measurements are cancelled/skipped partially. At least the following alternatives is considered for further study:  • Alt 1-1a: UE processes measurement with a predefined pattern of SSB indexes within a gap/restriction when the bit field in DCI indicates the skipping of gap/restriction  • Alt 1-1b: UE processes measurement with a predefined pattern of SSB indexes within a gap/restriction when the bit field in DCI indicates not skipping of gap/restriction.    Figure 9 Legacy RRC signaling indicates SSB symbols to be measured |

### Moderator's summary of contributions

A number of companies expressed their view related to partial skipping. The views are summarized below.

**Support partial skipping**: InterDigital, LG, Sony, TCL, Xiaomi, ZTE

* Skipping the entire gap occasion to allow data Tx/Rx can impact the quantity/quality of measurements: InterDigital
* If the UE perform transmission / reception for such short period then in practice, the UE can still continue to perform RRM measurement for the remaining measurement gap: Sony
* Not all of the measurement restriction need to RF chain switching, thus, portion of slots/symbols within a measurement restrictions can be used for data transmission/reception: TCL
* In some scenarios scheduling restriction is only for SSB symbols: ZTE

**Postpone the discussion**: Ericsson, MediaTek

* Better understanding for the baseline design with full cancellation should be established first prior to the discussion regarding the support of the partially cancelled/skipped: Ericsson, MediaTek

**Do not support partial skipping**: CATT, DOCOMO, OPPO

* When the data transmission is partial overlapping with the MG, the remaining time duration is not sufficient for RRM measurement until it is longer than the RF tuning time: CATT
* Large RAN4 impact, RAN4 needs complicated study that how to treat MG length: DOCOMO

### Low priority discussion: Round #1

Moderator’s comment:

Based on companies' contributions, different views about partial skipping were summarized above. Some companies support partial skipping as it gives more possibilities for measurements, other companies share their concerns about complexity of such behavior and not clear scenarios where measurements can be conducted taken into account the RF re-tuning time, etc. Benefits and drawbacks provided in companies contributions can be found in Section 2.5.2.

Moderator’s recommendation:

As was also commented during online session in RAN1#116-bis, the discussion on the partial skipping shall be postponed until the solution for full skipping is clear. **Therefore, moderator’s recommendation is to discuss the issue related to partial skipping at a later stage when RAN1 makes more progress on the full skipping solution.**

**Please, provide your view (in the table below) regarding the following question:**

|  |
| --- |
| **Q1:** Do you agree with moderator’s recommendation to postpone the discussion on partial skipping until the solution for full skipping is clear? |

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| **Company** | **Answers/Comments** |
| ZTE, Sanechips | From our perspective, it would be easy to specify the case of partial skipping after RAN1 makes more progress on the full skipping solution due to limited specification impact. To this end, partial skipping need to be further discussed. |
| Lenovo | Yes |
| Qualcomm | Q1: we do not support the partial MG skipping. |
| Huawei, HiSilicon | Support FL’s view. |
| TCL | Similar view as ZTE. |
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## Other issues

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Apple | Observation: there is no RAN1 agreement on RRM measurement adaptation evaluation methodology.  Proposal 9: When a slot is designated as not a “valid downlink slot” due to overlap with a configured measurement gap occasion, and that measurement gap occasion is skipped due to RRM measurement adaptation for XR, for the basic UE feature supporting RRM measurement adaptation, the slot is not converted into a “valid downlink slot” and the slot may be eligible to be designated as “valid downlink slot” subject to UE capability. |
| TCL | Proposal 7: Interaction between DRX and solutions to enable Tx/Rx during measurement restrictions can be studied.  Proposal 8: When more than one CG configurations activation simultaneously, a UTO-UCI use to indicate un-used TOs within more than one CG configurations can be considered. |

### Moderator's summary of contributions

There were few other issues raised in companies Tdocs. The issues are summarized below:

**Issue 1** - Valid downlink slot:

* In TS 38.214, regarding CSI reference resource determination, a so-called “valid downlink slot” is defined. A valid downlink slot cannot be inside a measurement gap. With the skipping/adaptation of measurement gap, whether a slot which is not a “valid downlink slot” previously due to its overlap with a measurement gap is changed into a “valid downlink slot” or not shall be discussed: **Apple**

**Issue 2** - Interaction with C-DRX:

* Further discuss: **TCL**

**Issue 3** - UTO-UCI for multiple CG configuration:

* Support extension of UTO-UCI to multiple CG configurations: **TCL**

### Low priority discussion: Round #1

Moderator’s comments and recommendation:

**Issue 1:** During RAN1#116 an agreement was made, saying: when an occasion(s) of gaps/restrictions that are caused by RRM measurements are cancelled/skipped fully, UE is assumed to receive/transmit in the gaps/restrictions that are caused by RRM measurements as it would without any (measurement etc. related) gaps/restrictions that are caused by RRM measurements. **From moderator’s point of view, the issue 1 (please see above the exact description) is related to that agreement and shall be discussed when solution for skipping is clear.**

**Issue 2:** The issue related to C-DRX and non-active time might be solved by some of the solutions currently discussed. **It is recommended that we postpone the discussion on C-DRX until a baseline solution has more details to see if any additional improvements are necessary.**

**Issue 3:** Extension of UTO-UCI to multiple CG configurations was not agreed to be part of Rel19 objectives, and **thus we do not continue the discussion**.

**Please, share your view (in the table below) related to the following question:**

|  |
| --- |
| **Q1:** Do you agree with moderator’s recommendations for Issues 1-3? If you do not agree, please share your view on possible alternative way forward. |

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| --- | --- |
| **Company** | **Answers/Comments** |
| Lenovo | Yes |
| Qualcomm | We agree with Moderator’s recommendations.  For issue 1, we think that the agreement has covered general UE Tx/Rx including the CSI-RS. Whether and how each specific Tx/Rx type is treated can be discussed once the basic MG skipping mechanism is clear. For issue 2, we think this can also be left to RAN2. For issue 1, we agree it is out of the WI scope. |
| Huawei, HiSilicon | Support FL’s view. |
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# Proposals for online sessions

## Online session on Tuesday

# Agreements

## RAN1#116

**Agreement**

Consider at least solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements.

* FFS: Other types of solutions.
* Whether or not/how to account for any UE assistance information/indication in addition to other information available at the network

**Agreement**

From RAN1 perspective, when an occasion(s) of gaps/restrictions that are caused by RRM measurements are cancelled/skipped fully, UE is assumed to receive/transmit in the gaps/restrictions that are caused by RRM measurements as it would without any (measurement etc. related) gaps/restrictions that are caused by RRM measurements.

* FFS: Whether or not/How to support of the case where an occasion(s) of gap/restrictions that are caused by RRM measurements are cancelled/skipped partially

**Agreement**

For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements consider the following alternatives or combinations for further down-selection:

* Alt. 1: Dynamic indication to enable Tx/Rx in particular gap(s)/restriction(s) that are caused by RRM measurements.
  + FFS: details
* Alt. 2: Semi-persistent solution to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements.
  + FFS: details
* Alt. 3: Semi-static solution to enable TX/RX in gaps/restrictions that are caused by RRM measurements.
  + FFS: details
* Alt. 4: Dynamic solution to adapt/change gap/SMTC configuration to enable TX/RX in gaps/restrictions that are caused by RRM measurements.
  + FFS: details
* Alt. 5: Rule-based solution to enable TX/RX in gaps/restrictions that are caused by RRM measurements:
  + FFS: details

Companies are encouraged to use the EVM in TR38.835 if they are submitting simulation results.

Working Assumption

RAN1 aims to develop/identify solution(s) to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements agnostic in RAN1 normative work to types of gaps/restrictions that are caused by RRM measurements.

Note: UE features related to the developed solution(s) is a separate discussion.

## RAN1#116-bis

**Agreement**

For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements consider the following alternatives or combinations for further down-selection:

* Alt. 1: Dynamic indication to enable Tx/Rx in particular gap(s)/restriction(s) that are caused by RRM measurements.
  + FFS: **Alt 1-1**: Explicit indication by DCI to skip a particular gap(s)/restriction(s);
  + FFS: **Alt 1-2**: Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s);
  + FFS: **Alt 1-3**: Implicit indication by DCI scheduling a transmission/reception overlapping with a gap(s)/restriction(s) to skip the gap(s)/restriction(s);
  + FFS: DCI format, DCI content, DCI bit-field size;
  + FFS: Whether indication is for one or more occasions;
  + FFS: How to consider time offset between the end of received dynamic indication and start of gap(s)/restriction(s) occasion that is going to be skipped.
* Alt. 2: Semi-persistent solution to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements.
  + FFS: **Alt 2-1**: gNB sends a skipping activation command, UE will skip gaps/restrictions until de-activation command is received.
  + FFS: **Alt 2-1a**: gNB sends an activation command to enable pre-configured gap(s)/restriction(s), UE will skip gap(s)/restriction(s) after de-activation command is received.
  + FFS: **Alt 2-2**: RRM measurement adaptation is applied to all MG configurations/scheduling restrictions due to all SMTC configurations, or is applied to selected MG configuration(s) and/or scheduling restrictions due to selected SMTC configuration(s) and is conducted in a time-window, and time-windows are derived from a semi-persistent ~~configuration~~ activation for their periodicity, offset and duration.
  + FFS: **Alt 2-3**: Activate/de-activate one or more of pre-configured pattern(s) via MAC-CE to indicate occasions where Tx/Rx is prioritized over gap(s)/restriction(s);
  + FFS: Details of activation/deactivation MAC-CE command
  + FFS: How to consider time offset between activation/deactivation command and start of gap(s)/restriction(s) occasion that is going to be skipped.
* Alt. 3: Semi-static solution to enable TX/RX in gaps/restrictions that are caused by RRM measurements.
  + FFS: **Alt 3-1**: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions;
    - FFS: Details of pattern
  + FFS: **Alt 3-2**: Gaps/restrictions skipping is applied to all MG configurations/scheduling restrictions due to all SMTC configurations / RRM measurements, or is applied to selected MG configuration(s) and/or scheduling restrictions due to selected SMTC configuration(s) / RRM measurement(s) and is conducted in a time-window, and time-windows are derived from a semi-static configuration for their periodicity, offset and duration.
  + FFS: **Alt 3-3**: Gaps/restrictions that are caused by RRM measurements are skipped if collided with particular semi-statically pre-configured Tx/Rx occasions.
  + FFS: **Alt. 3-4**: Gaps/restrictions that are caused by RRM measurements are skipped based on semi-statically configured priority information for particular semi-statically pre-configured Tx/Rx and/or particular gaps/restrictions.

**Agreement**

Confirm the working assumption from RAN1 #116 with updates:

* RAN1 aims to develop/identify solution(s) to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements agnostic in RAN1 normative work to types of gaps/restrictions that are caused by RRM measurements.
  + It is up to RAN4 to discuss which type of gaps/restrictions caused by RRM measurements can be cancelled/skipped
  + Note: UE features related to the developed solution(s) is a separate discussion

**Agreement**

RAN1 continues to discuss and decide whether or not to introduce new UE assistance information for solution(s) to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements. At least the following UE assistance information is considered for further study:

* FFS: UE assistance information related to measurement occasions:
  + FFS: The number of needed measurement gaps/SMTC with restrictions within a time period;
  + FFS: The maximum number or ratio of MGs/SMTC with restrictions that can be skipped within a time period;
  + FFS: The number of required SSBs within a time period;
  + FFS: The number of consecutive RRM measurements that can be skipped;
  + FFS: The maximum interval between two consecutively reserved gap/restriction occasions for RRM measurements;
  + FFS: The patterns of gap(s)/restriction(s) where skipping is feasible or acceptable;
* FFS: UE assistance information related to channel conditions:
  + FFS: RSRP is below/above search threshold (s-MeasureConfig);
* FFS: UE assistance information related to traffic:
  + FFS: PSI (PDU set importance);
* FFS: UE assistance information related to UE mobility:
  + FFS: L3 parameters related to mobility, e.g., static or not

Companies are encouraged to provide additional details (e.g. how often the UE assistance info is provided, timing, applicable scenarios, performance gains, etc) on their preferred scheme.

Note: From specification point of view, there is no mandated gNB behavior in response to any of the UE assistance information.

RAN1 to make decision, from RAN1 perspective, in RAN1#117 on the support of UE assistance information.

# References

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| --- | --- | --- |
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| [R1-2404389](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404389.zip) | Signaling control of scheduling restriction during measurement gap in support of XR services | CATT |
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| [R1-2404193](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404193.zip) | Discussion on enabling data transmissions for XR during RRM measurements | vivo |
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| [R1-2404738](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404738.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Panasonic |
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| [R1-2404932](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404932.zip) | On enabling Tx/Rx for XR during RRM measurements | Google Inc. |
| [R1-2404900](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404900.zip) | Discussion on XR during RRM measurements | LG Electronics |
| [R1-2404874](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404874.zip) | Enhancements to enable TX/RX for XR during RRM measurements | OPPO |
| [R1-2404606](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404606.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Xiaomi |
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| [R1-2404040](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_117/Docs/R1-2404040.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Spreadtrum Communications |