3GPP TSG RAN WG1 #118 R1-240xxxx

Maastricht, Netherlands, 19 – 23 August, 2024

**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#118 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** |
| 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. |
| CAICT | Proposal 1: The following aspects should be considered to enable TX/RX of XR traffic during RRM measurement gaps：1. balance the performance of XR service and RRM measurement
2. match the XR traffic model as much as possible
3. specification impacts and complexity
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| 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.](#_Toc174117044) |
| Fraunhofer IIS, Fraunhofer HHI | Observation 1: The solution which will be adopted by RAN1 to enable TX/RX in gaps/restrictions that are caused by RRM measurements must provide significant capacity improvements while at the same time taking RRM performance impact into account.Observation 2: The solutions based on Alt. 1 aim at providing the capacity improvements whereas the ones based on Alt. 3 aim at guaranteeing some minimum RRM performance requirements. |
| 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. |
| 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. |

### Dynamic indication (Alt. 1)

#### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| CAICT | Proposal 2: Alt.1-1 is supported as basic solution to enable Tx/Rx in measurement gaps. |
| CATT | Proposal 1: The Alt.1: dynamic indication solution should not be supported in Rel-19 XR enhancement, because it requires the 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 Alt. 1-1: Explicit indication by DCI to skip a particular gap(s)/restriction(s), support one-bit indication included as part of scheduling DCI.Proposal 4: 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. 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions;
* Alt. 1-1 + Alt. 3-1: configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions and explicitly indicate by DCI to skip a particular gap/restriction on top of the configured pattern(s).
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| 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 3 Support dynamic indication of cancellation of a MG occasion in a MG configuration by a bit-field in a DCI format carried by PDCCH as the baseline approach.• Bit-field size is one bit.• A bit in the cancellation field is associated to a MG occasion starting after the last symbol of the PDCCH carrying the DCI format and indicates whether the MG occasion 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.A screenshot of a computer  Description automatically generated**Figure 2:** 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 IIS, Fraunhofer HHI | Proposal 3: For the dynamic solution, support Alt. 1-1. The dynamic skipping/cancellation applies only to gaps/restrictions that are not already indicated as skipped/cancelled by the semi-static pattern. |
| 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.• Note: Alt. 1-1 and Alt. 1-3 can be supported for dynamic grant scheduling and Alt. 3-4 for configured grant scheduling. |
| Huawei | Observation 1: If the bit field is 1 bit, DCI to skip a particular gap(s)/restriction(s) (Alt 1-1) may introduce large signalling overhead. If the bit field is more than 1 bit, DCI indicating a time window (Alt 1-2) have least spec workload.Observation 2: Utilizing DCI to indicate multiple occasions skipping can reduce signalling overhead compared with using DCI to indicate a single occasion skipping.Observation 3: The bitmap pattern varies with the MG configurations or SMTC configurations, resulting in high design complexity. Observation 4: In typical UE implementation, a UE usually chooses a semi-static pattern to do measurement on a subset of the configured occasions, and the pattern does not change frequently. Alt 1-2 (dynamic indication) requires the UE to dynamically cancel or do measurement on an indicated occasion, which may not be aligned with typical UE implementation. Alt 3-1 (semi-static) is more friendly in terms of UE implementation.Proposal 1: For solutions based on triggering/enabling by network signalling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements: Support 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. FFS: Alt 1-2: Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s); Consider sending LS to RAN4 to discuss time offset, and UE implementation impact since Alt 1 requires UE to dynamically cancel or do measurement on an indicated occasion, which may not be aligned with typical UE implementation |
| InterDigital | Observation 3: Dynamic-indication based solutions enable the NW to control how much of the Tx/Rx of XR data can be allowed during RRM measurements and provide flexible means to handle any uncertainties in the XR traffic characteristicsObservation 4: Alt 1-2 and Alt 1-3 are less effective compared to Alt 1-1 due to additional overhead, increase in complexity and reduced flexibility at gNBObservation 6: Both dynamic indication-based and semi-static pattern based solutions have complementary benefits and are useful when applied in different scenarios (e.g. uncertainty in traffic characteristics, congestion/load conditions, link conditions). Proposal 1: Support explicit indication in DCI to skip particular gaps/restrictions (Alt 1-1)Proposal 2: For Alt 1-1 solution, support a multi-bit bitfield size for indicating the skipping of multiple gap occasions in the DCI  |
| 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.Proposal 4: If both Alt 1 and Alt 3 are supported, UE’s behaviour should be defined when the indications for the same MG are different.Proposal 5: Determine the time offset value before deciding whether to support any Alt1 variants.Proposal 6: The DCI (for Alt 1-1 if supported) with ‘m’ bit field size indicates which of the next (from the end of the corresponding PDCCH) 2^m “valid” measurement occasions to be skipped. * A valid measurement occasion satisfies the minimum time offset from the end of the last PDCCH reception candidate.

Proposal 7: The DCI (for Alt 1-2 if supported) with ‘m’ bit field size indicates measurement occasions within which window with a length out of possible 2^m possible window lengths (including ‘0’) to be skipped.* A window starts at the end of the corresponding last PDCCH reception candidate plus the time offset.
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| LG | Proposal 1: Consider supporting one or more solutions for both periodic and aperiodic gaps/restrictionsProposal 2: Support Alt. 1 for the solution to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements* For Alt. 1-1, it is necessary to discuss how Alt 1-1 constructs explicit indication and specifies gap/restrictions to be skipped.
	+ For example, DCI can indicate an index of gaps/restrictions configuration (where index for each of configuration can be preconfigured by RRC)
* For Alt 1-2, it is necessary to discuss how to define the time window and whether it is agnostic to different gaps/restrictions.
* For Alt. 1-3, it is necessary to discuss whether/how to introduce criteria to enable skipping.

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.
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| MediaTek | Observation 2: Dynamic indication to enable Tx/Rx is useful when network uses dynamic UL/DL grants to schedule XR packets.Proposal 7: 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.Proposal 2: Support solutions based on Alt.1-1.  |
| 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). Proposal 3: For the explicit indication, indication of multiple MGs/restrictions should be supported for better flexibility. |
| Nokia | Observation 1: In terms of configuration and introduced DCI overhead, Alt 1-2 appears to be most complex. Observation 2: Alternative 1-3 requires scheduling DL or UL resources (PDSCH/PUSCH) well in advance to overlap the measurement gap, effectively blocking the data scheduling until the resource allocation overlapping the measurement gap.Observation 3: Potential standardization of a new compact group common DCI format for MG skipping indication could be useful for cases where MG skipping is desirable to have sent with corresponding scheduling grant. This will offer lower radio resource overhead as compared to using e.g. DCI formats 0\_1/0\_2/0\_3 and/or 1\_1/1\_2/1\_3 with embedded MG skipping indication.Observation 4: Dynamic indication based on explicit DCI indication (Alt. 1-1) provides the best performance in terms of XR capacity and skipping ratio among the evaluated schemes.Proposal 1: Select Alt 1-1 for the dynamic indication to enable Tx/Rx in particular gap(s)/restriction(s) that are caused by RRM measurements.Proposal 2: Enable inclusion of MG skipping instruction for DCI formats 0\_1/0\_2/0\_3 and 1\_1/1\_2/1\_3. This shall be enabled through higher layer (e.g. RRC), so that the network decides in which of those DCI formats MG skipping signaling is enabled.Proposal 3: Priority is to first have simple single-bit MG skipping indication standardized (i.e. Alt 1-1). Secondly, extending it to a two-bit field, which is configured by higher layer signaling to e.g., explicitly indicating times of MG skipping, or type of MG skipping, could be further considered.

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| **Scheme** | **Alternative** | **Retune Time****TSRT [ms]** | **Capacity (PDB: 10ms) [#UEs/cell]** | **Capacity Loss (PDB: 10ms)** | **Capacity Gain (PDB: 10ms)** | **Skipping ratio** |
| No MGs | N/A | N/A | 7 | N/A | N/A | N/A |
| MGs enabled (40,6) | N/A | N/A | 4 | 43% | N/A | N/A |
| Genie | N/A | N/A | 7 | N/A | 75% | 72% |
| Explicit DCITB=3ms, TP=6ms | Alt 1-1 | 3 | 7 | 0% | 75% | 55% |
| Explicit DCITB=2ms, TP=6ms | Alt 1-1 | 4 | 6 | 14% | 50% | 50% |
| Explicit DCITB=1ms, TP=6ms | Alt 1-1 | 5 | 6 | 14% | 50% | 44% |
| Explicit DCITB=0ms, TP=6ms | Alt 1-1 | {1-6} | 6 | 14% | 50% | 38% |
| Explicit DCITB=3ms, TP=4ms | Alt 1-1 | 1 | 7 | 0% | 50% | 44% |
| Explicit DCITB=2ms, TP=4ms | Alt 1-1 | 2 | 6 | 14% | 50% | 38% |
| Explicit DCITB=1ms, TP=4ms | Alt 1-1 | 3 | 6 | 14% | 50% | 32% |
| Explicit DCITB=0ms, TP=4ms | Alt 1-1 | {1-6} | 6 | 14% | 50% | 26% |
| Pattern{16,8,12}ms | Alt 3 | N/A | 5 | 29% | 25% | 50% |
| Pattern{17,8,12}ms | Alt 3 | N/A | 5 | 29% | 25% | 43% |
| Pattern{16,8, 1st PDU} | Alt 3 | N/A | 5 | 29% | 25% | 45% |
| Pattern{17,8,1st PDU} | Alt 3 | N/A | 5 | 29% | 25% | 43% |

Table 1 (short) – Results of SLS in DU deployment with (MG interval, MG gap length) equal to (40,6) ms. N/A means Not Applicable.  |
| NTT DOCOMO | Observation 1: 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: 1 bit in scheduling DCI indicates skipping for the first gap/restriction which is with a required duration after the DCI. |
| OPPO | Observation 2: The range of k1 (which is up to 15) and k0/k2 (which is up to 32) in current spec are sufficient 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.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 indication by DCI to skip a gap(s)/restriction(s):
	+ Explicit 1-bit indication in DCI format X\_1/2/3 is used to indicate whether to skip the first gap(s)/restriction(s) occasion after a minimum time offset required between the end of a received DCI and the start of corresponding skipped gap(s)/restriction(s) occasion indicated by the DCI.
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| Panasonic | Proposal 1: A dynamic indication should be supported for MG skipping. A DCI should carry a dedicated filed, indicating a new PHY priority index for scheduled resource or a number of MG occasions to be canceled. |
| Qualcomm | Observation 1: In comparison to the XR data scheduling DCI based implicit MG skipping indication, the non-scheduling DCI based indication provides more signaling capability and indication flexibility and it also has more specification impact.Observation 2: The non-scheduling DCI based MG skipping indication may rely on prediction of XR data arrival time and packet size which may not be feasible based on current RAN1 understanding of XR traffic characteristics.Observation 4: scheduling the latency critical XR data in concentrated time domain resources and staggering data transmissions for different users in time are effective techniques in achieving high system throughput for XR traffic.Observation 5: it is questionable whether dynamic MG skipping indication via the XR data scheduling DCI would work given there needs to be large time offset between the DCI and the MG.Observation 7: given the understanding that XR data arrival time and packet size are not predictable, non-scheduling DCI based dynamic solution is not superior to RRC message based semi-static solution. |
| 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 located after a minimum processing time from the ending symbol of the PDCCH providing the DCI format (and continues receptions/transmissions if the UE skips the next MG). Observation 1: There is no need and is disadvantageous for a gNB to indicate to a UE to skip multiple MGs. |
| Sony | Proposal 1: Support and prioritize 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.Proposal 3: Other solution(s) than dynamic indication can be further studied (e.g., on the applicability, and scenarios). |
| 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 4: Implicit indication solution may cause delay for data transmission/reception in the case of same slot scheduling.](#_Toc13947)[Proposal 1: Support to specify Alt 1. dynamic indication to enable Tx/Rx in particular gap(s)/restriction(s) that are caused by RRM measurements.](#_Toc23744)[Proposal 3: Support to specify Alt 1-1: Explicit indication by DCI to skip a particular gap(s)/restriction(s):](#_Toc278)[• Bit-field size is at least one bit](#_Toc16812)[• DCI format: 1\_x, 0\_x.](#_Toc26460)[Proposal 4: 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):](#_Toc14755)[• Bit-field size is at least one bit](#_Toc19384)[• DCI format: 1\_x, 0\_x.](#_Toc16879)[Proposal 5: 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).](#_Toc17491)Figure 2: Example of explicit indication by DCI to indicate a time window |

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

#### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Apple | Proposal-2: Support Alt 3-1 from RAN1 #117 with a periodic 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 periodic configurations can be activated.Proposal-4: support non-integer periodicity for periodic configuration targeting RRM measurement gap adaptation (skipping).Proposal 5: 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.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 3: For the semi-static solution, UE could default the RRM cancelation behavior until disable flag received via the RRC re-configuration.Proposal 4: For the semi-static solution, UE could also terminate or suspend the RRM cancelation behavior based on the following aspects:* The XR transmission is completed a time offset prior to the start of upcoming measurement gap, which is enough for preparing the upcoming RRM measurement.
* The XR transmission is not expected to be scheduled within the upcoming measurement gaps indicated by the Rel-17 PDCCH skipping indication.
* UE receives the DRX command MAC CE a time offset prior to the start of upcoming measurement gap, which is enough for preparing the upcoming RRM measurement.
* UE reports the CG-PUSCH TOs with the value of '1' via the UTO-UCI, in which the Tx/Rx are not collided with the upcoming measurement gap.
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| CMCC | Proposal 2: For Alt. 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions, support that the pattern(s) is based on a bitmap.Proposal 3: For Alt. 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions, the pattern(s) can be applied to all configured MG configurations/scheduling restrictions for simplicity.Proposal 4: 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. 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions;
* Alt. 1-1 + Alt. 3-1: configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions and explicitly indicate by DCI to skip a particular gap/restriction on top of the configured pattern(s).
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| 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 are not supported. |
| Fraunhofer IIS, Fraunhofer HHI | Proposal 2: For the baseline semi-static solution, support Alt. 3-1. The semi-static pattern can be kept simple, i.e., periodic, and holds until the next RRC Reconfiguration. |
| 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.• Note: Alt. 1-1 and Alt. 1-3 can be supported for dynamic grant scheduling and Alt. 3-4 for configured grant scheduling. |
| Huawei | Observation 4: In typical UE implementation, a UE usually chooses a semi-static pattern to do measurement on a subset of the configured occasions, and the pattern does not change frequently. Alt 1-2 (dynamic indication) requires the UE to dynamically cancel or do measurement on an indicated occasion, which may not be aligned with typical UE implementation. Alt 3-1 (semi-static) is more friendly in terms of UE implementation.Proposal 1: For solutions based on triggering/enabling by network signalling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements: Support 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. FFS: Alt 1-2: Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s); Consider sending LS to RAN4 to discuss time offset, and UE implementation impact since Alt 1 requires UE to dynamically cancel or do measurement on an indicated occasion, which may not be aligned with typical UE implementation**Figure 3.** Example of cancelling the measurement gaps based on overlapping ratio |
| InterDigital | Observation 2: Legacy semi-static approaches for reconfiguring gaps/restrictions to avoid overlap with the data can cause additional delays when addressing jitter during XR data arrival Observation 5: In comparison to Alt 3-1, solutions in Alt 3-3 and Alt 3-4 have higher spec effort and their applicability is restricted to fewer scenariosObservation 6: Both dynamic indication-based and semi-static pattern based solutions have complementary benefits and are useful when applied in different scenarios (e.g. uncertainty in traffic characteristics, congestion/load conditions, link conditions). Proposal 3: Support configuring pattern(s) via RRC to indicate the occasions where to skip gaps/restrictions (Alt 3-1)Proposal 4: For Alt 3-1 solution, support configuration of the following parameters for the patterns for skipping gaps/restrictions: periodicity, start offset and duration per occasion Proposal 5: For Alt 3-1 solution, support the skipping pattern that is configurable for a subset of MG configurations/restrictions |
| Lenovo | Proposal 3: Adopt Alt 3-3 for semi-static/semi-persistent scheduling.Proposal 4: If both Alt 1 and Alt 3 are supported, UE’s behaviour should be defined when the indications for the same MG are different. |
| LG | Proposal 1: Consider supporting one or more solutions for both periodic and aperiodic gaps/restrictionsProposal 4: 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 like approaches, which requires to configure pattern to enable TX/RX
* Introduce a new RRC parameter to indicate where the cancellation/skipping is applied.
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| MediaTek | Proposal 6: 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 generatedFigure 3 Time-domain mask configuration can relax scheduling restrictions on time instances where XR traffic is expected to be transmitted/received. |
| Nokia | Observation 5: Semi-static pattern-based solutions require a precise timing configuration of the pattern to result in worth-while performance benefits, and occasional reconfiguration of the parameters to ensure good performance.Observation 6: With configured pattern the skipping duration/length cannot be dynamically adjusted. This prevents the optimization of the skipping duration/length LS to minimize the skipping ratio.Proposal 7: 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. Proposal 8: For Alt 3-1, we suggest that the pattern is defined from the following parameters:1. periodicity of the pattern (PS) is signaled using integer or non-integer cycles from a given set of possible fractional cycles (i.e. similar as for DRX XR use cases as standardized for Rel-18);
2. the duration/length of the pattern (LS) (where scheduling is always prioritized) is configurable;
3. the offset of the pattern (OS) is also configurable, taking values from 0 to the periodicity minus one (either expressed in units of integer slots or milliseconds).

Proposal 9: If Alt 3-1 is adopted, at least a formula shall be specified to identify the pattern and measurement occasions to be skipped. |
| NTT DOCOMO | Observation 2: 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.Proposal 3: If Alt 3 is supported in addition to Alt 1, further study the sub-alternatives:* Alt 3-1: Bitmap based skipping pattern is configured for per MG/SMTC/RRM configuration.
* Alt 3-3: Whether to skip overlapping gap or scheduling restriction occasions is configured for a SPS/CG configuration.
* Alt 3-4: A skipping priority value can be configured for a SPS/CG configuration, indicating whether to skip and to skip which types of gap or scheduling restriction occasions.
 |
| OPPO | Proposal 1: Alt 3-3 is supported 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 |
| Panasonic | Proposal 2: The semi-static solutions should be considered for MG skipping for a better support of CG/SPS. It can be realized by introducing a new PHY priority index to CG/SPS configurations or the enable/disable MG skipping cycle. |
| Qualcomm | Proposal 3: support semi-static and semi-persistent solutions for indicating MGs that are skipped for UE Tx/Rx.Observation 6: MAC CE based semi-persistent solution has a good balance between flexibility, signaling latency and overhead. It is beneficial to use MAC CE to deactivate MG configurations and indicate MGs to be skipped. |
| Samsung | Observation 2: There is no need and is disadvantageous for a gNB to semi-statically indicate skipped MGs to a UE. |
| Spreadtrum | Proposal 1: Alt 3-1 can be one candidate solution, considering the following aspects:1. Configure a RRC pattern based on periodicity and a bitmap to indicate occasions where to skip gaps/restrictions;
2. RRC Pattern is based on periodicity and a bitmap
3. Pattern periodicity can be the least common multiple of XR traffic periodicity and MG periodicity
4. A configured pattern includes usable information of gap(s)/restriction(s) occasions, e.g., bit 0 represent to do measure in gaps/restrictions, while bit 1 represents to enable Tx/Rx in gaps/restrictions.
 |
| TCL | Proposal 5: Priority rule for enabling Tx/Rx for XR during RRM measurement can be considered(Alt 3-4). |
| vivo | Proposal 1: For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements, prioritize the following alternatives.* 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;
		- Pattern is based on a bitmap;
	+ 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.
 |
| Xiaomi | Observation3：The scheme based on dynamic indications does not align well with the target use case where non-integer periodic XR services do not align with integer periodic RRM..Proposal 3：Support Alt 3-1 as the solution to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements. |
| ZTE | [Observation 1: For semi-static solution, it is hard to obtain a reasonable overlapping pattern between gap/restriction occasion and packet transmission/reception.](#_Toc7257)[Observation 2: Semi-static solution results in either capacity performance loss or measurement performance loss.](#_Toc31626) |

### Combination of alternatives

#### Companies proposals and observations

|  |  |
| --- | --- |
| **Company** | **Proposals/Observations** |
| CMCC | Proposal 4: 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. 3-1: Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions;
* Alt. 1-1 + Alt. 3-1: configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions and explicitly indicate by DCI to skip a particular gap/restriction on top of the configured pattern(s).

**Figure 1.** Illustration of the combination solution of Alt. 1-1 and Alt. 3-1 |
| Fraunhofer IIS, Fraunhofer HHI | Proposal 1: Support a combination of Alt. 3 (baseline) and Alt. 1 (complement) to enable TX/RX in gaps/restrictions that are caused by RRM measurements. The combination is a logical “OR”. |
| 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.Note: Alt. 1-1 and Alt. 1-3 can be supported for dynamic grant scheduling and Alt. 3-4 for configured grant scheduling. |
| Lenovo | Proposal 4: If both Alt 1 and Alt 3 are supported, UE’s behaviour should be defined when the indications for the same MG are different. |
| LG | Proposal 1: Consider supporting one or more solutions for both periodic and aperiodic gaps/restrictions |
| MediaTek | Proposal 5: Support both dynamic indication (Alt-1) and semi-static solution (Alt-3) for network-controlled mechanism. |
| Nokia | Proposal 5: Alt 3 can be considered as complements to Alt 1-1. But, as Alt 1-1 offers better flexibility it should be standardized first. Proposal 6: If semi-static solutions are considered as a complementary to Alt 1-1, we prefer Alt 3-1. |
| Spredtrum | Proposal 2: Alt 3-1 + Alt 1-1 can be one candidate solution, considering the following aspects:1. Configure a RRC pattern based on periodicity and a bitmap to indicate occasions where to skip gaps/restrictions, using dynamic indication to revise one or more gaps/restrictions.
2. RRC Pattern is based on periodicity and a bitmap, e.g., bit 0 represent to do measure in gaps/restrictions, while bit 1 represents to enable Tx/Rx in gaps/restrictions
3. A new bit field with one bit in DCI format to revise the skipping information and applicable to the next MG/restriction after time offset
4. When a gap/restriction occasion is indicated as “cancelled (1)” earlier, gNB is not allowed to be indicated as “NOT cancelled (0)” later; when a gap/restriction occasion is indicated as “NOT cancelled (0)” earlier, gNB is allowed to be indicated as “cancelled (1)” later.
 |

### Moderator's summary of contributions

In the previous RAN1#117 meeting, further down-selection of different alternatives for network signaling were agreed. A summary of companies views regarding these alternatives together with benefits and drawbacks is provided below.

|  |  |  |
| --- | --- | --- |
| **Alternative** | **Benefits** | **Drawbacks** |
| **Support Alt. 1-1:** CAICT, CMCC, Ericsson, Fraunhofer (in combination), Google (in combination), InterDigital (in combination), Lenovo, MediaTek (in combination), Meta, Nokia, NTT DOCOMO. OPPO (2nd priority), Samsung, Sony, ZTE **(15)****Support Alt. 1-2:** Huawei, ZTE, Lenovo **(3)****Support Alt. 1-3:** Google (in combination), Lenovo, OPPO (1st priority), TCL **(4)****Support Alt. 1:** LG, NEC, Panasonic **(3)****Do not support Alt. 1:** CATT | **Alt. 1:**Provides flexibility and reasonable balance between XR traffic and RRM measurement according to the instantaneous situation, applicable for XR traffics regardless of XR traffic characteristic: **CAICT, NTT DOCOMO**Application packet arrival uncertainty handling: in reality, traffic arrival is not perfectly periodic due to jitter and exact traffic arrival time is unknown: **Ericsson, Samsung** Application packet size uncertainty handling: The application packet size is not fixed and varies over time so that although the packet arrival is before the MG occasion, skipping the next MG may or may not be needed depending on the packet size: **Ericsson, Samsung** Scheduling uncertainty handling: Although the packet arrival from or for a specific user collides with a MG, it does not mean that gNB decides to skip a MG since it may need to prioritize the other user which does not collide with any MG. Note that MG configuration is UE specific so not all users have the same MG occasions: **Ericsson** Retransmission uncertainty handling: **Ericsson, Samsung**Alt. 1-3: The benefit of this implicit indication method is that no new DCI or new DCI field will be introduced: **NEC, OPPO** | **Alt. 1:**DCI miss detection issue needs to be considered for Alt.1: **vivo****Comparison of Alt. 1-1 vs Alt. 1-2 vs Alt. 1-3**Alt. 1-2: More signalling overhead and specification impact as compared to Alt. 1-1 and Alt. 1-3: **CMCC**Alt. 1-2 would require additional UE complexity for identifying the time window and then comparing the identified time window with one or multiple MGs, and may also result to additional specification impact/clarifications such as whether/when one MG is partially included in the indicated time window: **Samsung**Alt. 1-3: the types of Tx/Rx that can be enabled in gaps/restrictions are limited to the dynamically scheduled Tx/Rx: **CMCC, Spreadtrum**Alt. 1-3: UE cannot distinguish the DCI is scheduling a delay-critical traffic or a delay non-critical traffic: **Huawei**Alt. 1-3: If existing PDSCH/PUSCH scheduling timeline (Tproc1/Tproc2) or UL cancellation timeline (T’proc2) is used, Alt 1-3 is feasible. However, if the processing time requires several subframes (e.g. 5ms), Alt 1-3 is not appropriate, since it may be not typical to schedule a PDSCH/PUSCH in advance for a long time offset: **NTT DOCOMO** |
| **Details of sub-alternatives****Alt. 1-1** (Explicit indication by DCI):* Bit-field size is:
	+ One bit: **CMCC, Ericsson, Nokia (1st priority), NTT DOCOMO, OPPO, Samsung**
	+ Multi-bit: **InterDigital, Nokia (2nd priority), ZTE, NEC**
* DCI format is
	+ Scheduling DCI X\_1/2/3: **Ericsson, Nokia, OPPO**
	+ Introduce new DCI format: **LG**
* A bit in the cancellation field is used to indicate whether to skip the first gap(s)/restriction(s) occasion after a minimum time offset required between the last symbol of the PDCCH carrying the DCI format and the start of corresponding skipped gap(s)/restriction(s) occasion indicated by the DCI: **Ericsson, NTT DOCOMO, 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**
* A DCI should carry a dedicated filed, indicating a new PHY priority index for scheduled resource or a number of MG occasions to be canceled: **Panasonic**

**Alt. 1-2** (Explicit indication by DCI to indicate a time window):* A window starts at the end of the corresponding last PDCCH reception candidate plus the time offset: **Lenovo**
* [Bit-field size is at least one bit](#_Toc19384): **ZTE**
* [DCI format: 1\_x, 0\_x:](#_Toc16879) **ZTE**
* If the DCI field has 2bits and a ‘00’ value for the bits indicates no skipping in RRM measurements with gaps/restrictions, ‘01’, ‘10’, ‘11’ values for the bits indicates skipping RRM measurements with gaps/restrictions within different length of time windows: **Huawei**

**Alt. 1-3** (Implicit indication by DCI):* 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: **TCL**
 |
| **Support Alt. 3-1:** Apple, CMCC, Fraunhofer (in combination), Huawei, InterDigital (in combination), MediaTek (in combination), Spreadtrum, Xiaomi **(8)****Support Alt. 3-3:** CATT, Lenovo (for SPS/CG), LG, OPPO (for SPS/CG) **(4)****Support Alt. 3-4:** Google (for SPS/CG), LG, TCL **(3)****Support Alt. 3:** Panasonic, Qualcomm, vivo **(3)****Do not support Alt. 3:** Ericsson | **Alt 3:**More friendly in terms of UE-implementation: **Huawei, Qualcomm**Signaling reliability can be guaranteed: **vivo**A UE usually chooses a semi-static pattern to do measurement on a subset of the configured occasions, and the pattern does not change frequently: **Huawei**Alt. 3-3: no additional signaling overhead when applied for CG/SPS: **OPPO** | **Alt. 3:**XR traffic is not strictly periodic. For example, single stream DL traffic was modeled as a sequence of video frames arriving at gNB according to the considered video frame rates and random jitter. The size of each frame is also random according to a certain distribution: **CAICT, InterDigital, Ericsson**It is difficult to predict the XR traffic model values since the period, data arrival interval and the payload size could vary faster than RRC (re)configuration: **CAICT**A UE may experience a poor channel condition and it is preferred to do measurement for potential handover to another cell than being served with the incoming XR traffic. These aspects are not known in advance to the NW to be handled by configuration. Any semi-static based solution would be unnecessarily conservative approach: **Ericsson**The gNB serves multiple UEs and cannot predict the scheduling situation long in the future to determine a proper configuration that satisfy simultaneously different needs of the multiple UEs: **Ericsson**Any reconfiguration of the gap parameters (e.g. gap length, repetition periodicity) with RRC signaling as done in legacy results in delays: **InterDigital****Comparison of Alt. 3-1 vs Alt. 3-3 vs Alt. 3-4:**Alt.3-1: RRC configuring a pattern(s) to indicate the occasions where to skip gaps/restrictions, the pre-configured patterns based on the periodicity/offset and duration or a bitmap might not be fully adapted to the XR traffic transmission with the delay jitters: **CATT**Alt. 3-3 and Alt. 3-4 are applicable to semi-statically pre-configured Tx/Rx, e.g., SPS and CG, but not applicable to dynamically scheduled Tx/Rx: **CMCC, Huawei** |
| **Details of sub-alternatives****Alt. 3-1** (Configure a pattern(s) via RRC):* Pattern is:
	+ A time-window period, a time-window offset and time-window duration are provided to derive time windows: **Apple, Huawei, InterDigital, MediaTek, Nokia**
		- 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**
		- Non-integer periodicity support: **Apple**
	+ RRC Pattern is based on periodicity and a bitmap: **Spreadtrum**
	+ Pattern is based on a bitmap: **CMCC, vivo**

**Alt. 3-3** (skipped if collided with particular semi-statically pre-configured Tx/Rx occasions):* Disable flag via RRC re-config determines whether to cancel MG/restrictions or not: **CATT**
* 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** (skipped based on semi-statically configured priority information):* a skipping priority value can be semi-statically configured for a SPS/CG configuration, indicating whether to skip and to skip which types of gap or scheduling restriction occasions: **NTT DOCOMO**
 |
|  |
| **Several sub-alternatives:****Alt. 1-1 + Alt. 3-1**: CMCC, Fraunhofer, Spreadtrum, Nokia (2nd priority), InterDigital (independent solutions)* Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions and explicitly indicate by DCI to skip a particular gap/restriction on top of the configured pattern(s): **CMCC**
	+ Benefits: Since the semi-static solution Alt. 3-1 is more friendly to UE implementation but provides less flexibility than the dynamic solution Alt. 1-1, the combinations of Alt. 1-1 and Alt. 3-1 can be considered to merge the advantages of them.
* Configure a pattern(s) via RRC to indicate occasions where to skip gaps/restrictions additional occasions not covered by RRC pattern are indicated by DCI if needed: **Fraunhofer**
	+ The dynamic signaling can only apply to gaps/restrictions which are not already indicated as skipped/cancelled by the semi-static pattern: **Fraunhofer**

**Alt. 1-1/Alt. 1-3** (for dynamic grant) + **Alt. 3-4** (for SPS/CG): Google**Alt. 3 + Alt. 1**: LG, MediaTek (separate solution for SPS/CG), NTT DOCOMO, OPPO (Alt. 3-3 separate solution for SPS/CG) |

### 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 2.1.5.

According to the contributions submitted to RAN1#118 the following list is identified:

* Alt. 1-1 (15 companies) – majority support based on contributions
* Alt. 3-1 (8 companies) – second supported sub-alternative
* Sub-alternatives Alt. 1-1 + Alt. 3-1 (5 companies) - third supported option
* Alt. 3-3 (4 companies)
* Alt. 1-3 (4 companies)
* Sub-alternatives from Alt. 1 + Alt. 3 (4 companies)
* Alt. 3-4 (3 companies)
* Alt. 1-2 (3 companies)
* Sub-alternatives Alt. 1-1/Alt. 1-3 + Alt. 3-4 (1 company)

Moderator’s recommendation:

To maintain progress, in this meeting RAN1 shall agree upon the solution from the list above. RAN4 and RAN2 can then continue working on their parts of a solution. Companies are encouraged to select their preferred solution. The drawbacks and benefits of each sub-alternative are summarized in Section 2.1.5 based on companies' contributions, in case some important aspects are missing, it would be helpful to add those below along with the preferred solution.

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

|  |
| --- |
| **Q1:** Please, choose your preferred sub-alternative from Alt. 1 and motivate your selection:* Support Alt. 1-1
* Support Alt. 1-2
* Support Alt. 1-3

**Q2:** Please, choose your preferred sub-alternative from Alt. 3 and motivate your selection: * Support Alt. 3-1
* Support Alt. 3-3
* Support Alt. 3-4

**Q3:** Do you support several sub-alternatives above? If yes, please indicate your preferred sub-alternatives, motivate your choice, and provide details on an overall solution(s). |

|  |  |
| --- | --- |
| **Company** | **Answers/Comments** |
| InterDigital | Q1: Alt 1-1In comparison to other sub-alternatives, Alt 1-1 provides the most flexibility to NW to decide on whether/when to enable Tx/Rx during gaps. It is important to have such flexibility at the NW scheduler given the uncertainties in XR traffic (e.g. variable payload, jitter) and the need to mitigate any impacts on RRM measurements. Q2: Alt 3-1Complexity-wise, the semi-static pattern in Alt 3-1 provides a balanced approach to enable some data Tx/Rx when gaps are configured without much overhead. It has comparable spec impact with that of Alt 1-1 and lower than those of Alt 3-3 and Alt 3-4 (e.g. no need for priority or impacts due to SPS/CG occasions). However, it may lack the flexibility provided by Alt 1-1. Q3: Although our general preference is for one sub-alternative, we are open to consider several sub-alternatives (i.e. one from dynamic indicated-based and another from semi-static based alternatives). This is because the different sub-alternative solutions have benefits that are complementary and can be useful when applied in different scenarios (e.g. link conditions, traffic uncertainty).  |
| Qualcomm | Q1: without additional restrictions, Alt. 1 may impact UE RRM measurement and implementation significantly. We do not support Alt. 1 if companies intend to only adopt the dynamic solution.Q2: Alt. 3-1 is a general semi-static solution. We think at least Alt. 3-1 should be adopted.Q3: for the joint dynamic and semi-static solution, we do not support to the combination that both RRC and DCI indicates MGs to skip separately. For example, the DCI indication should be restricted to a set of MGs that can be potentially skipped and the set is indicated by RRC.  |
| Fraunhofer | Q1: Alt. 1-1.Q2: Alt. 3-1.Q3: Support Al. 1-1 + Alt. 3-1. The combination is a logical “OR”. Alt. 3 is always “on” and Alt. 1 comes on top of it. The two alternatives run in parallel on two totally distinct subsets of occasions of gaps/restrictions. The emphasis is to guarantee the RRM performance (i.e., Alt. 3-1) while still some capacity improvements can be achieved (Alt. 1-1). |
| CMCC | Q1: We support **Alt. 1-1**.Among Alt. 1, Alt. 1-1 is the most flexible and simplest solution. Compared to Alt. 1-1, it seems that Alt. 1-2 involves more specification impact but does not show any convincing benefit. And Alt. 1-3 has obvious limitations on the types of Tx/Rx that can be enabled in gaps/restrictions caused by RRM measurements.Q2: We support **Alt. 3-1**.Among Alt. 3, Alt. 3-3 and Alt. 3-4 are applicable to semi-statically pre-configured Tx/Rx, e.g., SPS and CG, but not applicable to dynamically scheduled Tx/Rx. Compared to them, Alt. 3-1 is a general solution for both semi-statically pre-configured and dynamically scheduled Tx/Rx although it is more suitable for the former.Q3: We **support to consider two sub-alternatives, i.e., Alt. 1-1 and Alt. 3-1**. In general, Alt. 3-1 is more suitable for semi-statically pre-configured Tx/Rx and is more friendly in terms of UE implementation, while Alt. 1-1 is more suitable for dynamically scheduled Tx/Rx and provides more flexibility. Considering the characteristics of XR traffic including semi-periodic DL/UL video traffic with jitter, periodic DL/UL audio traffic, and periodic UL pose/control traffic, both Alt. 1-1 and Alt. 3-1 can be supported to enable Tx/Rx of XR traffic in gaps/restrictions that are caused by RRM measurements. Furthermore, to simplify the UE implementation and reserve flexibility of NW indication, we **support the combination of Alt. 1-1 and Alt. 3-1**. That is, NW configures a skipping pattern(s) via RRC first, then sends a dynamic indication by DCI to further skip a particular gap/restriction on top of the configured skipping pattern. |
| DOCOMO | Q1: Alt 1-1.Q2: Alt 3-4. Q3: We are fine to support Alt 1-1 + Alt 3.  |
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## Timeline discussion

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Ericsson | Proposal 4 For dynamic indication for cancellation of a MG (i.e. Alt. 1) in a MG configuration, 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. If preferred, the discussion and decision can be deferred to RAN4.• The reference for the cancellation timeline is the start of the cancelled MG.• The cancellation timeline should only be satisfied for the first indication of a cancelled MG. |
| Huawei | Proposal 1: For solutions based on triggering/enabling by network signalling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements:  Support 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. FFS: Alt 1-2: Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s); Consider sending LS to RAN4 to discuss time offset, and UE implementation impact since Alt 1 requires UE to dynamically cancel or do measurement on an indicated occasion, which may not be aligned with typical UE implementationFigure 2. Illustration of time offset between the end of received dynamic indication and start of gap(s)/restriction(s) |
| Lenovo | 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 8: If DCI-based dynamic indication is supported, the related discussion on minimum processing time value(s) are left to RAN4.  |
| Nokia | Proposal 4: The value of T that represents the UE processing time acting on such measurement gap skipping indication(s) is desirable to take single fixed value for all UEs supporting this feature (say e.g. corresponding to one slot).  |
| OPPO | Observation 1: The time offset between the end of DCI reception and the start of the skipped gap(s)/restriction(s) occasion needs to take into account the PDCCH decoding, PUSCH preparation and measurement re-planning. |
| Qualcomm | Observation 3: Tproc1, Tproc2, UL cancellation timeline and PUSCH preparation time N2 are more relevant to the cancellation of data channels instead of UE RRM measurement. Rel-17 dynamic deactivation of preconfigured MGs is the most relevant mechanism to the Rel-19 MG skipping feature.Proposal 1: Support to reuse the timeline of Rel-17 dynamic deactivation of preconfigured MGs• For eMBB UE, at least 5ms time offset is needed after the MG skipping indication is decoded to the start of the MG. For RedCap UE, the minimum required time offset can be longer.Proposal 2: Support UE capability report for the minimum required time offset between when the MG skipping indication signaling is decoded and the start of the MG to skip. |
| Spreadtrum | Proposal 3: Minimum time offset between the end of received dynamic indication and start of gap(s)/restriction(s) occasion in time window that is going to be skipped shall be introduced, i.e., 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. |
| ZTE | [Observation 5: The scenarios of activating/deactivating for pre-MG is distinguished from the RRM measurement enhancement in AI 9.10.1.](#_Toc13272)[Proposal 6: RAN1 consider to reuse the time offset of activating/deactivating one DL PRS process window for the minimum time offset(s) between the end of received dynamic indication and start of corresponding gap(s)/restriction(s) occasion that is going to be skipped.](#_Toc3775) |

### Moderator's summary of contributions

During the previous meeting RAN1#117, 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:** Qualcomm
	+ Values are up to RAN4: MediaTek
	+ RRM measurements are highly related to UE implementation: MediaTek
	+ Since RRM measurement highly depends on UE implementation, it should be reasonable to assume different UEs see different challenges in the new Rel-19 MG skipping feature: Qualcomm
* **Up to RAN4:** MediaTek, Huawei
* **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: ZTE**
		- N2 as in R17 Positioning is used in the determination of the PRS measurements: ZTE
	+ **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**

This issue exists in all solutions including the dynamic, semi-persistent and semi-static ones, though it is less critical for the semi-persistent and semi-static solutions: **Qualcomm**

### 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#118, 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.

To summarize, the range for time offset values proposed in contributions is from <1 ms up to 5 ms. It is worth noting that, even for 5 ms, the simulation results from Nokia demonstrated better performance in terms of capacity and number of skipped measurements for Alt. 1-1 as compared to Alt. 3 (pattern-based solution). Thus, from moderator’s point of view, the final decision on supported solution shall not depend on the exact value to be agreed beforehand.

Moderator’s recommendation:

Moderator’s recommendation is to leave the discussion on particular value(s) for time offset up to RAN4 in case Alt. 1 is selected. In RAN1 we can discuss whether time offset is UE capability or not and what is a range for the time offset. To facilitate the discussion, moderator would like to get more input from companies with the help of question below:

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

|  |
| --- |
| **Q1:** In case Alt. 1 is selected, what is your view related to timeline? Please, choose the option below and elaborate your answer. * **Option 1:** Minimum time offset X between indication to skip and skipped measurement occasion is up to UE capability.
	+ Range for minimum time offset is [Y, … Z], where Y is less than 1 ms and Z is 5 ms.
	+ Exact values are up to RAN4 decision.
* **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 the exact value for minimum time offset X between indication to skip and skipped measurement occasion. Please, choose the minimum time offset X:
	+ 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).
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| **Company** | **Answers/Comments** |
| InterDigital | We tend to agree with moderator’s recommendation that the time offset can be left to RAN4 (Option 2). RAN1 can continue to discuss on solution details for Alt 1-1, possibly based on the baseline assumption on the range for the time offset.  |
| Qualcomm | For the timeline, we proposed to adopt the Rel-17 dynamic indication of preconfigured gap for eMBB UE. For RedCap UE, this timeline needs to be further relaxed. We think it is proper to define UE capabilities so that different UE implementations can report the supported minimum time offset. The Rel-17 dynamic deactivation of preconfigured MGs was handled by RAN4. For this, it is also fine to us to leave the timeline discussion to RAN4. For option 3, only the Rel-17 dynamic deactivation of preconfigured MGs is relevant to the current Rel-19 feature. So only the Rel-17 design should be used as reference. Our first preference is option 1, second is option 2, and third is option 3. |
| Fraunhofer | Our preference is Option 2. It is actually not clear to us what operations have to be performed between the time that the DCI is received and the start of the corresponding gap(s)/restriction(s) that is skipped/cancelled, beyond the decoding of the DCI. It is therefore uncertain to what extent and how much we can reuse any of the time offsets of the alternatives listed in Option 3 about the timeline for the indication of gaps/restrictions to be cancelled/skipped. For that reason, we think that it is more appropriate to let RAN4 discuss this issue and decide.In addition, we see that SA2 has sent RAN2 an LS asking whether the periodicity and time to next burst (i.e. the time interval between the current burst and the next burst) could be useful for RAN resource scheduling, especially with regard to the possible jitter between the NG-RAN and the Application Server (S2-2407351). If available, this information would be very useful for the scheduler to determine whether the upcoming burst will overlap a gap/restriction and to dynamically skip/cancel it. |
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## Other types of solutions

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Google | 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.Proposal 3: For a configured grant transmission, skip a measurement gap depending on the remaining delay budget for the transmission.Proposal 4: Skip a measurement gap if the priority of the overlapping transmission is above a configured priority threshold. |
| 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). |

### Moderator's summary of contributions

The views related to additional solutions are summarised below.

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

* 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 selects 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** |
| InterDigital | Agreed |
| Qualcomm | Agreed with moderator’s recommendation. |
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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. |
| Ericsson | Proposal 5 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. |
| Fraunhofer IIS, Fraunhofer HHI | Proposal 4: RAN1 continues to discuss whether the partial skipping/cancellation of occasion(s) of gaps/ restrictions that are caused by RRM measurements is supported or not. |
| InterDigital | Proposal 6: Postpone the discussion on partial skipping until further progress is made on the solutions in Alt 1 and Alt 3 |
| LG | Proposal 5: 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.  |
| NTT DOCOMO | Proposal 4: Not support the case where an occasion of gap/restrictions caused by RRM measurements are cancelled/skipped partially. |
| 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 4: 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.Proposal 2：Partial cancellation or skipping of gaps or restrictions caused by RRM measurements could be futher discussed in RAN1. |
| ZTE | Proposal 7: The case where an occasion(s) of gap/restrictions that are caused by RRM measurements are cancelled/skipped partially should not be excluded.Proposal 8: RAN1 continues to discuss and decide whether or not to introduce 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 1-4: Explicit indication by DCI to skip symbols for SSB indexes to be measured in gaps/restrictions• Alt 1-5: Explicit indication by DCI to activate a pre-defined pattern for SSB indexes to be measured in gaps/restrictions. |

### Moderator's summary of contributions

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

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

* 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, InterDigital 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, InterDigital, MediaTek**
* Skipping the entire gap occasion to allow data Tx/Rx can impact the quantity/quality of measurements: **InterDigital**

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

### Low priority discussion: Round #1

Moderator’s comment:

Based on companies' contributions, 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 2.4.2.

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:**

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| **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** |
| InterDigital | Fine to discuss at later stage on whether/how the solutions for skipping can be leveraged to support partial skipping. No need to deprioritize partial skipping at this stage.  |
| Qualcomm | We support to drop partial skipping of MG for Rel-19 and this can be discussed later. |
| Fraunhofer | We agree to discuss the issue later. |
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## Other issues

### Companies proposals and observations

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| **Company** | **Proposals/Observations** |
| Apple | Proposal 6: 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.  |
| MediaTek | Proposal 3: Wait for RAN4 progress and/or response before further discussing UE assistance information. |
| OPPO | Proposal 4: If multiple MG configurations are configured to a UE, RAN1 further studies the execution order between R17/18 collision handling for concurrent measurement gaps and R19 enabling Tx/Rx in gaps/restrictions (regardless of Alt.1 vs. Alt.3).**Proposal 4**: If multiple MG configurations are configured to a UE, RAN1 further studies the execution order between R17/18 collision handling for concurrent measurement gaps and R19 enabling Tx/Rx in gaps/restrictions (regardless of Alt.1 vs. Alt.3). |
| Qualcomm | Observation 8: it does not essentially increase gNB implementation difficulty if the gNB follows UAI related to measurement occasions.Proposal 4: support UAI related to measurement occasions including• Maximum number of MGs that can be skipped within a duration• Ratio of MGs that can be skipped within a duration• Pattern of MGs that can be skipped |
| 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: UE assistance information indicating the number of gap(s) / restriction(s) that can be skipped during a configured RRM measurement is beneficial in the operation of XR transmission during RRM measurement.Observation 3: 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. |
| TCL | Proposal 6：UE assistance information/indication to notify gNB whether enabling Tx/Rx for XR during RRM measurements restriction can be considered.Proposal 7: Interaction between DRX and solutions to enable Tx/Rx during measurement restrictions can be studied. |
| vivo | Proposal 2: Enhancement on enabling Tx/Rx in gaps/restrictions that are caused by RRM measurements outside DRX active time is not considered in R19. |
| ZTE | [Observation 3: Multiple configurations can be configured and activated for one UE, where the measurement gap occasions from different configurations may overlap in time domain.](#_Toc6681)[Proposal 2: Discuss how to indicate overlapped gap(s)/restriction(s) in multiple configurations.](#_Toc26269) |

### Moderator's summary of contributions

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

**Issue 1** - Valid downlink slot:

* 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: **Apple**

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

* Further discuss: **TCL**
* Enhancement on enabling Tx/Rx in gaps/restrictions that are caused by RRM measurements outside DRX active time is not considered in R19: vivo

**Issue 3** - UE assistance information:

* Wait for RAN4 progress and/or response before further discussing UE assistance information: MediaTek
* Support UAI related to measurement occasions: Qualcomm, TCL

**Issue 4**: Discuss collision between concurrent measurement gap (TS 38.133 Clause 9.1.8.3): ZTE

* If multiple MG configurations are configured to a UE, RAN1 further studies the execution order between R17/18 collision handling for concurrent measurement gaps and R19 enabling Tx/Rx in gaps/restrictions (regardless of Alt.1 vs. Alt.3): OPPO
	+ - Option 1: R17/18 collision handling is performed first, and then R19 enabling Tx/Rx in gaps/restrictions (regardless of Alt.1 vs. Alt.3) is applied to the surviving MG.
		- Option 2: R19 enabling Tx/Rx in gaps/restrictions (regardless of Alt.1 vs. Alt.3) is performed first, and then R17/18 collision handling is applied to the non-skipped MGs.

### Low priority discussion: Round #1

Moderator’s comments and recommendations:

**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, issue 1 (please see above the exact description) is related to that agreement and shall be discussed when a 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:** The issue related to UE assistance information. RAN1 concluded the discussion at the last meeting. Unless a specific request is received from other working groups, the discussion remains closed for the time being.

**Issue 4:** This issue is related to collision of concurrent measurement gaps. It is recommended that RAN1 discusses this issue after a solution for skipping is selected.

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

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| **Q1:** Do you agree with moderator’s recommendations for Issues 1-4? If you do not agree, please share your view on possible alternative way forward. |

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| **Company** | **Answers/Comments** |
| InterDigital | Agree |
| Qualcomm | For issue 1, we agree that this heavily depends on whether the MG skipping is dynamic or semi-static. It can only be proceeded after the signaling design is determined.For issues 2 to 4, we also agree with moderator. |
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# Offline sessions

## Offline session on Tuesday

# 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.

## RAN1#117

**Agreement**

For solutions based on triggering/enabling by network signaling to enable Tx/Rx in gaps/restrictions that are caused by RRM measurements, select one or combination among only Alt1 and Alt3 from RAN1#116bis.

**Conclusion**

RAN1 does not further discuss new UE assistance information related to channel conditions, traffic, UE mobility.

Proposal 2.1.2-v7

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);
		- Indication is included as part of scheduling DCI:
			* FFS: Bit-field size is one bit;
			* FFS: Bit-field size is >1 bit;
		- Note: Minimum time offset(s) between the end of [the first] received dynamic indication and start of corresponding gap(s)/restriction(s) occasion that is going to be skipped shall be introduced.
	+ FFS: **Alt 1-2**: Explicit indication by DCI to indicate a time window where to skip a particular gap(s)/restriction(s);
		- Note: Minimum time offset between the end of received dynamic indication and start of gap(s)/restriction(s) occasion in time window that is going to be skipped shall be introduced.
	+ 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);
		- Note: Minimum 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 introduced.
	+ 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. 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: Pattern is based on periodicity, offset and duration;
			* FFS: Pattern is based on a bitmap;
		- FFS: whether a pattern is applied to all or subset of configured MG configurations/scheduling restrictions.
	+ 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.

**Conclusion**

There is no consensus in RAN1 to support UE assistance information related to measurements occasions. The reason for this situation is lack of consensus on the need/feasibility for UAI and lack of technical understanding on issues outside of RAN1 expertise (e.g. impact of RRM measurement performance). It is up to other working groups to trigger further work in RAN1 on UE assistance information.

Proposal 2.3.3-v4:

RAN1 agrees to send an LS to RAN4 (CC: RAN2) to convey the following information about UE assistance information (including the conclusion on UAI):

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| --- | --- |
| **1. Overall Description:**RAN1 discussed UE assistance information related to measurements occasions and related to channel conditions, traffic, UE mobility. The following agreement and conclusions were agreed:

|  |
| --- |
| **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.**Conclusion**RAN1 does not further discuss new UE assistance information related to channel conditions, traffic, UE mobility.**Conclusion**There is no consensus in RAN1 to support UE assistance information related to measurements occasions. The reason for this situation is lack of consensus on the need/feasibility for UAI and lack of technical understanding on issues outside of RAN1 expertise (e.g. impact of RRM measurement performance). It is up to other working groups to trigger further work in RAN1 on UE assistance information. |

Particularly, it was discussed whether impact on RRM performance from skipping measurement occasions may be reduced if UE sends additional information: * Information about the maximum number of MGs/SMTC with restrictions that can be skipped within a time period.
* Information about the patterns of gap(s)/restriction(s) where skipping is feasible or acceptable.

**2. Actions:****To RAN4:****ACTION:** RAN1 kindly asks RAN4 to consider the above information into account and decide whether or not to introduce any UE assistance information related to measurement occasions. |

Final LS in R1-2405736.

# References

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| --- | --- | --- |
| [R1-2405843](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405843.zip) | Discussions on scheduling enhancements considering RRM measurements for XR | Huawei, HiSilicon |
| [R1-2405886](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405886.zip) | Enhancements to enable TX/RX for XR during RRM measurements | Fraunhofer IIS, Fraunhofer HHI |
| [R1-2405929](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405929.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Spreadtrum Communications |
| [R1-2406002](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406002.zip) | Discussion on enabling TX/RX for XR during RRM measurements | CMCC |
| [R1-2406065](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406065.zip) | Enabling TX/RX for XR during RRM measurements | Nokia |
| [R1-2406081](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406081.zip) | Enabling TX/RX for XR during RRM measurements | Lenovo |
| [R1-2406201](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406201.zip) | Discussion on enabling data transmissions for XR during RRM measurements | vivo |
| [R1-2406248](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406248.zip) | Enhancements to enable TX/RX for XR during RRM measurements | OPPO |
| [R1-2406274](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406274.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Xiaomi |
| [R1-2406304](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406304.zip) | Discussion on Enabling TX/RX for XR During RRM Measurements | Meta |
| [R1-2406358](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406358.zip) | Signaling control of scheduling restriction during measurement gap in support of XR services | CATT |
| [R1-2406415](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406415.zip) | Discussion on measurement gap for XR | ZTE Corporation, Sanechips |
| [R1-2406428](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406428.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Panasonic |
| [R1-2406487](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406487.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Sony |
| [R1-2406506](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406506.zip) | Discussion on enabling TX/RX for XR during RRM measurements | InterDigital, Inc. |
| [R1-2406540](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406540.zip) | Discussion on enabling TX/RX for XR during RRM measurements | NEC |
| [R1-2406614](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406614.zip) | Discussion on XR during RRM measurements | LG Electronics |
| [R1-2406669](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406669.zip) | Discussion on enabling TX/RX for XR during RRM measurements | Samsung |
| [R1-2406770](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406770.zip) | Enabling TX RX for XR during RRM measurements | MediaTek Inc. |
| [R1-2406787](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406787.zip) | On enabling Tx/Rx for XR during RRM measurements | Google Ireland Limited |
| [R1-2406862](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406862.zip) | Views on Enabling TX/RX for XR during RRM measurements | Apple |
| [R1-2406899](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406899.zip) | Enabling TX/RX for XR during RRM measurements | TCL |
| [R1-2406948](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406948.zip) | Discussion on Enaling TX/RX for XR during RRM | NTT DOCOMO, INC. |
| [R1-2407048](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407048.zip) | Enabling Tx/Rx for XR during RRM measurements | Qualcomm Incorporated |
| [R1-2407155](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407155.zip) | Discussion on TX/RX for XR during RRM measurements | CAICT |
| [R1-2407162](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407162.zip) | RRM measurement gap and scheduling restriction enhancements to TX/RX XR traffic | Ericsson |